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A COST EFFECTIVENESS STUDY OF PREFABRICATED MEMBRANCE SURFACINGS

W. C. Grenke, et al

Wilson, Nuttal, Raimond Engineers, Incorporated

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13. ABSTRACT

Results are presented on a cost effectiveness study of expedient prefabricated membrane surfacings for use on military airfields in theaters of operations. The purpose of the study was to provide a basis for deciding whether to develop a family of membranes of various weights, or a single membrane of optimum weight to meet requirements set forth in a Department of the Army Approved Qualitative Materiel Requirement. Existing data and experience were collected, criteria for membrane effectiveness were developed, and important parameters identified. Models were developed for theaters of operation, performance, cost and effectiveness. A trade-off analysis, cost-effectiveness study, and membrane development plan are presented. The principal conclusion is that it is desirable to develop a family of membranes consisting of heavy, medium, and light duty classes for airfield traffic areas. It is recommended that development continue on the three-membrane system for traffic areas as outlined in the text. It is also recommended that research and development begin on an extra-light duty membrane for use on non-traffic areas and beneath landing mats.

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PREFACE

The work reported herein was performed by WNRE Incorporated (WNRE), Chestertown, Maryland, for the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, under Contract DACA 39-69-C-0021, during the period 25 September 1968 to 30 May 1969. The principal investigators were W. C. Grenke, Project Engineer, and C. J. Nuttall, Jr., Senior Engineer.

WES personnel directly concerned with this project were S. G. Tucker, Project Engineer and Chief, Membrane Section; W. L. McInnis, Chief, Expedient Surfacing Branch and Alternate Chairman, Project Advisory Group (PAG); A. A. Maxwell, Assistant Chief, Soils Division and Chairman of the PAG; W. J. Turnbull, former Chief, Soils Division (retired); and J. P. Sale, Chief, Soils Division. COL L. A. Brown, CE, was Director of WES, and F. R. Brown was Technical Director during the project.

W. R. Barwick, Headquarters, U. S. Army Materiel Command (AMC) and W. A. Niemeyer, U. S. Army Materials Systems Analysis Agency, were PAG members. R. G. Marshall, AMC, was a former member of the PAG.

The authors acknowledge contributions to the study by WES and PAG personnel through their cooperation, advice, and criticism. The assistance of G. R. Kozan and LT R. W. McVicar, both of AMC, and LTC J. P. Godsey, U. S. Army Combat Developments Command (CDC), Engineer Agency, is also appreciated.

The contract under which this report was prepared was monitored by S. G. Tucker. Contracting Officer was COL L. A. Brown, CE.

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I. INTRODUCTION

BACKGROUND

1. Prefabricated membrane surfacings are required to provide the Army with improved capability to produce the required aircraft landing facilities, in theaters of operations, which are essential for support of air mobility concepts. The primary function of the membrane is to provide a rapid means of waterproofing and dustproofing airfield runways, helipads, taxiways, aircraft parking areas, and military roads around airfields. The membrane may be used for this purpose under landing mats or, where soil strength is adequate, as the main wearing surface, in which case it must also provide an all-weather nonskid surface for proper aircraft control, particularly when short-field takeoff and landing procedures are used. Use of the membrane will enable in-situ soil strength to be maintained, reducing airfield construction and maintenance effort required, and provide dust control, reducing safety hazards to aircraft operation and airfield detection.

2. The wide variation in severity of service conditions is such that three weights (strengths) of membrane are currently in use or under engineering development. These are all neoprene-coated nylon fabrics with characteristics listed in Table 1.

Table 1

Neoprene Coated Nylon Fabric Membranes

Membrane Designation	Average Tensile Breaking Strength (lb/in)	Weight (lb/sq ft)	Relative Cost
T-16 (1 ply)	480	0.130	1
T-17 (2 ply)	956	0.333	2
WX-18 (4 ply)	2058	0.456	3

Tabulated data for several membranes which have been tested in the laboratory or in the field are presented in Appendix D.

3. A Department of the Army Approved Qualitative Materiel Requirement for Prefabricated Airfield Surfacings (QMR) has

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been developed which lists the desired functional characteristics of membranes, based on experience with current membranes but involving some apparently reasonable improvements, particularly in weights and placement rates (Ref. 1).* While three classes of membranes are contemplated (light, medium, and heavy duty), the QMR also expresses the desire to simplify the procurement, stocking, and distribution of membranes by the use of a single membrane for all severities of service. By implication, a rational system using only two weights of membrane would also be responsive to this general goal.

OBJECTIVE

4. The objective of this study is to provide a basis for deciding whether to develop a family of membranes of various weights, or a single membrane of optimum weight, to satisfy military requirements for membrane as set forth in the QMR.

STUDY BOUNDS

5. For the purpose of this study, a prefabricated membrane is defined as a thin, soft, pliable sheet fabricated at a factory so that field installation will consist mainly of assembling and uniting standardized parts. Other means of waterproofing and dustproofing, such as extra-light landing mat, surfacings which are not prefabricated (e.g., sprayed-on coatings), or chemical soil stabilization, are not considered.

6. Although the membrane surfacings may be utilized to support air operations in any land area of the world, primary use is expected to be in underdeveloped areas where airfields are either non-existent or inadequate. The use of such membranes on ice or snow subgrades (e.g., winter subarctic and arctic operations) is not anticipated. Secondary uses of membranes are not considered.

7. Three families of membranes involving one, two, or three membrane weights (duty classes), respectively, were examined for use on airfield traffic areas. A fourth membrane weight class was considered for use on non-traffic areas. Each

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*For convenience, a copy of the QMR is included in Appendix A.

family was optimized for selected theater scenarios with the stipulation that the QMR must be satisfied for each airfield in each theater. In addition, for a given optimum family of membranes, three alternative policies for membrane use in the construction of a given class of airfield were examined:

a) The use of only one membrane, of those available in a family (i.e., the membrane which satisfies the heaviest duty requirement of the airfield), throughout the airfield (used for two- or three-membrane families).

b) The optimum use of two membranes of those available in a family to satisfy the duty requirements of the various portions of the airfield (used for three-membrane families).

c) The optimum use of all membranes in a family to satisfy the duty requirements of the various portions of the airfield (used for one- to three-membrane families).

8. Membrane performance is defined as the capability of the membrane to withstand applied loads from aircraft or wheeled ground vehicles while providing a means of waterproofing and dustproofing graded subgrades at airfields. Other performance characteristics specified in the QMR which are independent of applied wheel loads (e.g., resistance of adverse effects from POL spillage and ambient temperature variations) are assumed to be met by the membrane material; otherwise the material must be rejected out of hand.

APPROACH

9. To accomplish the overall objective, the study consisted of three major phases of analysis:

a) Phase I: A trade-off analysis was performed to determine the effect on membrane cost and mission effectiveness resulting from specific changes to the QMR. The following parameters were considered:

1. Performance (operational capability)
2. Weight
3. Reliability and durability
4. Transportability
5. Maintainability
6. Placement rate
7. Producibility
8. Logistical support
9. Availability
10. Service life

b) Phase II: A cost effectiveness analysis was performed to determine the most cost-effective membrane, or combination of membranes, from those currently available that are capable of satisfying the QMR. Criteria for membrane effectiveness and models for cost and effectiveness were developed. Effectiveness parameters were weighted to reflect their relative importance and priority according to the general guidance of the QMR and of the Project Advisory Group (PAG). A sensitivity analysis was performed on important parameters to determine what variations in effectiveness would result from changes in the value of these parameters.

c) Phase III: To answer the basic question posed in the overall study objective, a membrane development plan is provided, based on the results of Phases I and II. Technical characteristics for the membrane(s) most suitable for military requirements are recommended.

10. Before the analyses indicated under Phases I, II, and III could be undertaken, several preliminary tasks had to be performed. These included collection of available data and experience, identification and definition of important parameters, and development of models and programs to facilitate the analysis.

DATA SOURCES

11. Much of the required data for this study was found in standard technical bulletins and manuals and in data packages supplied by WES. Standard planning rates for military personnel costs and shipping costs were supplied by AMC. Data on theater scenarios were not readily available and unanticipated delays were encountered in obtaining the desired information in suitable form. Although some information was obtained directly from the CDC Engineer Agency, additional estimates and assumptions were required to develop the theater models.

12. A list of literature used in this study is provided under REFERENCES.

MEMBRANE EFFECTIVENESS CRITERIA

13. An essential and critical task is the development of criteria for membrane effectiveness. After installation, a membrane becomes a part of an airfield, which is a

facility to permit operation, storage, and maintenance of some array of aircraft types (including helicopters) in various quantities. The airfield is a subsystem of various aerial surveillance, transport, and/or combat systems. Therefore, the lowest order at which membrane effectiveness may usefully be studied is at the level of its influence upon airfield effectiveness. For this suboptimization, it is felt that feedback into the major systems is not appropriate; i.e., study at the airfield effectiveness level is not only necessary but also adequate.

14. The controlling function of an airfield of a given class is to permit takeoff and landing of specified aircraft. The effect of membrane damage upon the airfield function is to interfere with this basic capability. Accordingly, it appears that one primary measure of airfield effectiveness (and hence membrane effectiveness) for the present study will be the membrane-related airfield availability. Since the membrane is merely one of many components upon which airfield effectiveness depends, a cost effectiveness study in which membrane effectiveness is held constant is thought to be both appropriate and adequate.

15. At this point some definitions and explanatory notes on terminology are in order. Membrane-related airfield availability is defined in this study as the percentage of time during a 24-hour day when aircraft takeoffs and landings are not prohibited due to membrane inspection, damage, or repair. It is assumed that damages to the membrane are repaired as they occur.

16. In discussing availability, the word "failure" has carefully been avoided in connection with membrane damage because the QMR defines a failure as a repair necessitating more than 24 manhours of engineer effort to restore. Thus a damage to the membrane (i.e., a break or tear) may reduce availability but may not constitute a failure.

17. Placement rate and service life of the membrane will also influence the effectiveness of the airfield and must therefore be included as a part of the membrane effectiveness criteria. Placement rate is the rate at which the membrane is initially installed in terms of square feet per manhour. Since placement rate is expressed in square feet per manhour, the effective placement rate is the placement rate times crew size. Service life of the membrane is the number of sorties for which the total area of membrane of a given type expended for repairs reaches 10 percent of the total airfield area covered by membrane of that type.

18. Membrane effectiveness is determined by the following:

a) How soon the membrane-covered airfield is available after initial airfield construction is completed (placement rate).

b) How much it is available on a day-to-day basis (availability).

c) How long it is available after the membrane is installed (service life).

Membrane effectiveness is expressed in terms of placement rate, availability, and service life (see EFFECTIVENESS).

II. DEVELOPMENT OF MODELS

OVERALL ASSUMPTIONS

19. The development of models for the cost effectiveness study was influenced by the following overall assumptions:

a) Traffic areas* of airfields in theaters of operations will be surfaced with membrane or landing mat over membrane or left bare.

b) A given airfield will use the same means of surfacing for all traffic areas, although different duty classes for a given type of surfacing may be intermixed.

c) The lightest available membrane will be used under all landing mat.

d) The lightest available membrane will be used for water/dustproofing non-traffic areas,** if required.

e) Membrane under mats requires no maintenance per se to meet QMR.

f) Placement rate for membrane under mats is not considered.

g) In systems involving more than one weight of membrane, all membranes will be of the same basic construction and material, e.g., a family of neoprene-coated nylon fabrics.

h) Membrane service life will be expressed as the number of sorties during which the total amount of membrane expended on repairs does not exceed 10 percent of the total airfield area covered by membrane of the same type.

i) Initial strength requirements for each membrane duty class will be based upon availability, maintenance, and service life requirements, with placement rate being dependent.

j) Rate of occurrence of membrane damage is a function of the number of sorties (of a given aircraft and load) and is independent of time, per se.

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*Includes runways, taxiways, warmup aprons, parking areas, and helipads.

**Includes shoulders, overruns, and peripheral areas where water/dustproofing is required.

k) The subgrade strength (airfield index) remains adequate for the critical aircraft of a given airfield.

l) Subgrade strength effects on membrane service life will be neglected.

m) Tire wear effects, other than those reflected in the mean sorties between damage, will be ignored; e.g., loss of antiskid surface with time.

n) For the purpose of placing membranes of optimum weight, "runway ends" (i.e., the landing zone) will be defined as 1/6 of the length of the runway on each end of the strip, and "runway centers" will be defined as the center 2/3 of runway length.

MEMBRANE PERFORMANCE UNDER AIRCRAFT WHEEL LOADS

20. The following assumptions were made regarding membrane performance:

a) Nominal maximum tensile load on membrane under aircraft loading is given by TECOM formula (Ref. 2):

$$NL = \frac{GW \times C_f}{n \times b} \times K_L \quad \text{lb/in.} \tag{1}$$

where GW = aircraft weight, lb
C_f = coefficient of friction, tire to membrane surface
n = number of tires in main landing gear
b = tire section width, in.
K_L = material compliance, multiwheel and/or dynamic multiplier
= 1.0 for TECOM formula (neoprene-coated nylon fabric; up to 4 tires in main gear; aircraft up to C-130).

b) Nominal tensile strength (NS) of membranes is the mean of mean warp and mean fill breaking strengths. For current membranes for which experience is available (all neoprene-coated nylon), these figures are as follows:

T-16:	NS = 480 lb/in.	(Ref. 4)
T-17:	NS = 956 lb/in.	(Ref. 2)
WX-18:	NS = 2058 lb/in.	(Ref. 3).

While numerous membranes have been subjected to field testing in varying degrees, only these three have been subjected to a variety of wheel loads and reported in sufficient detail to permit the establishment of a performance model.

c) Mean sorties between tears for a given membrane in a given section of an airfield under traffic from a given aircraft is primarily a function of the ratio of nominal tensile load to nominal tensile strength, i.e.,

$$MSBD = f(NL/NS). \tag{2}$$

d) With a membrane which is marginal to acceptable for service with a given aircraft loading, tears occur most frequently at runway ends, at touchdown.

Available Data on Membrane Tears

21. Tests of membrane performance under aircraft wheel loads have been documented for three neoprene-coated nylon fabrics (T-16, T-17, and WX-18) subjected to traffic by one or more of the following aircraft: O-1, OV-1, CV-2, and C-130. These data are summarized in Table 2.

Aircraft Data and Nominal Loadings

22. For the aircraft types and loads given in Table 2, nominal tensile loads on membranes were computed by using the TECOM formula (1) as shown in Table 3. The coefficient of friction, C_f, is assumed to be 0.5 (Ref. 2), and the multiplier, K_L, is set equal to 1.0.

Analysis

23. From Tables 2 and 3, membrane load/strength ratios and mean sorties between damage (MSBD) were computed and are included in Table 4. These values are plotted in Fig. 1, from which for runway ends, an approximate relationship for mean sorties between damage is given by

$$MSBD_E \approx 5(NS_E/NL)^3. \tag{3}$$

It is noted from the T-17 tests (Table 2) that the number of tears on runway ends was roughly eight times greater than on runway centers. Thus, for runway centers

$$MSBD_C \approx 40(NS_C/NL)^3; \tag{4}$$

while for taxiways and parking areas, with less confidence,

$$MSBD_T \approx 320(NS_T/NL)^3. \tag{5}$$

These three relationships are shown as dotted lines in Fig. 1.

Table 2

Summary of Membrane Performance Data

Membrane	Aircraft	Test Weight[1] (lb)	Sorties[2]	Tears			Reference
				Runway Ends[3]	Runway Center[3]	Taxi-Park	
T-16	O-1	2,000	33	0	-	-	5
	OV-1	12,000	184	29	-	-	5
T-17	OV-1	13,000	102	1	0	0	2
	CV-2	25,000	36	0	0	0	2
	C-130	81,000	75	8[4]	0	0	3
	C-130	115,000	288	33	4	0	2
WX-18	C-130	75,000	48	0	0	0	3
	C-130	127,000	107	3	0	0	3

[1]Data pooled where full information on distribution of landing weights not given, or when range is small and tears were few. If weights are known, average take-off weight during test is used. If weights are not given, maximum take-off weight is assumed.

[2]Where number of landings and take-offs are not equal, number of landings is taken as number of sorties.

[3]Ends = 1/6 length at each end, center = 2/3 in center.

[4]"Misses" during WX-18 tests, assumed to be in T-17 panels 300-500 feet from runway end; i.e., within "runway end" zone defined in footnote 3.

Table 3

Nominal Tensile Loads on Membranes

Aircraft	Test Weight (lb)	No. Tires in Main Gear	Tire Width (in.)	NL (lb/in.) (C_f=0.5, K_L=1.0)
O-1	2,000	2	5.95	84
OV-1	12,000	2	7.4	406
OV-1	13,000	2	7.4	439
CV-2	25,000	4	9.5	330
C-130	75,000	4	17.1	548
C-130	81.000	4	17.1	590
C-130	115,000	4	17.1	840
C-130	127,000	4	17.1	925

Table 4

Analysis of Membrane Performance Data

Membrane	Aircraft	Test Weight (lb)	$\frac{NL}{NS}$	MSBD = $\frac{\text{Sorties}^1}{\text{Tears}}$ Runway Ends	Runway Center	Taxi-Park
T-16	O-1	2,000	.18	>44	-	-
T-16	OV-1	12,000	.85*	6.2	-	-
T-17	OV-1	13,000	.46*	58.3	>131	(>131)
T-17	CV-2	25,000	.35	>48	(>48)	(>48)
T-17	C-130	81,000	.62*	8.6	>100	(>100)
T-17	C-130	115,000	.88*	8.5	61	>384
WX-18	C-130	75,000	.27	>64	(>64)	(>64)
WX-18	C-130	127,000	.45*	28.5	>143	(>143)

[1] No test sequence ended on a tear. In calculating MSBD, it was assumed in all cases that 3/4 of the interval to the next tear was exhausted at the end of the sequence; i.e., that "3/4" of a tear more than recorded had occurred. On line 2, for example, 184 sorties and 29 tears give 184/(29+3/4)=6.2 sorties per tear.

Parentheses indicate no data available. The numbers shown indicate minimum expected values and are obtained from the more severe runway centers or ends.

*Tears recorded for these tests only.

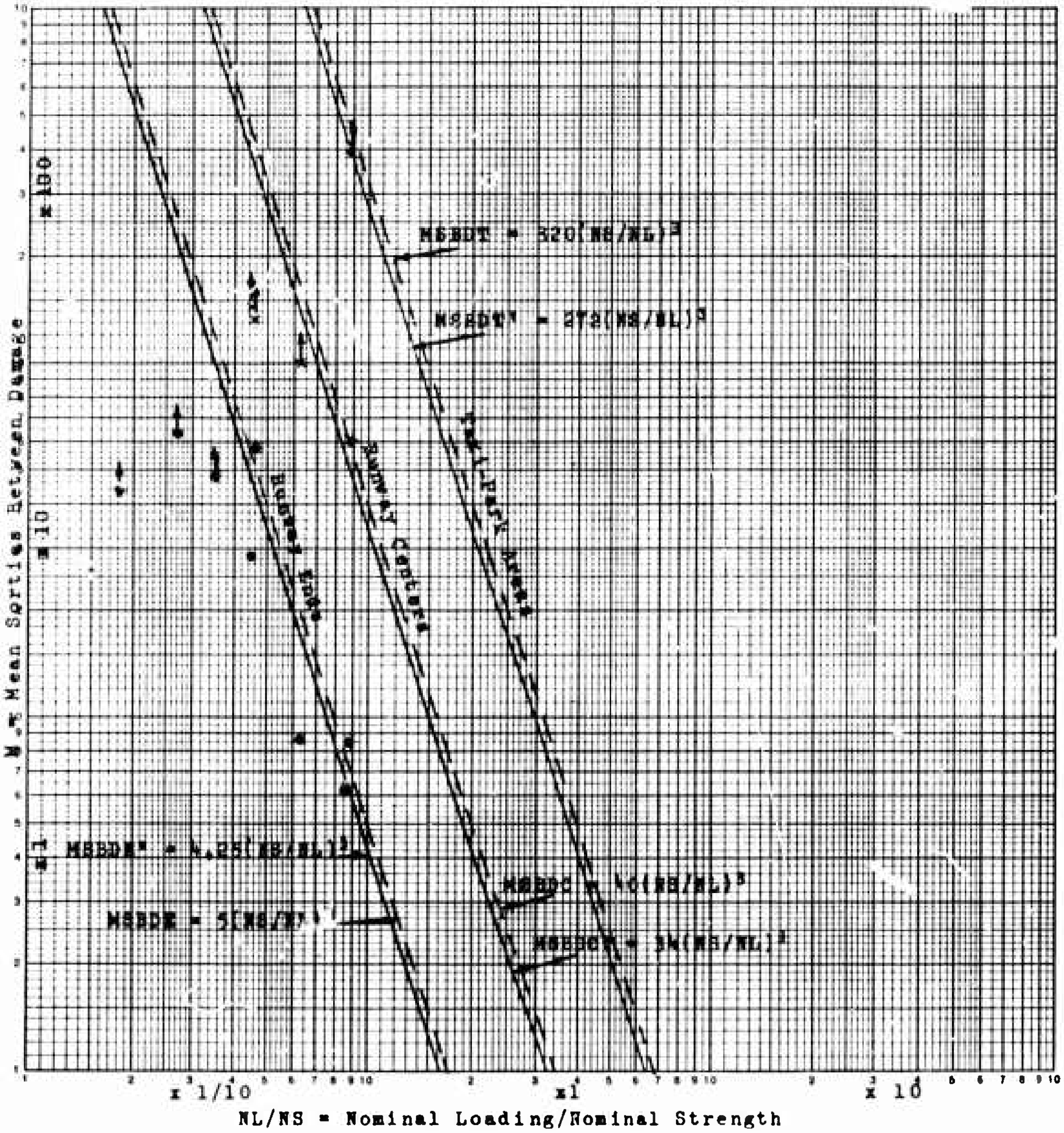

Figure 1. Membrane performance under aircraft wheel loads.

A Check Point from Vietnam Experience

24. During 15 June to 28 June 1966 at the "Golf Course" airfield near An Khe, Republic of Vietnam, 76 tears occurred in T-17 membrane when subjected to the traffic listed in Table 5 (Ref. 6). From the curves in Fig. 1 (eq. 3,4,5), the expected number of tears due to the traffic indicated in Table 5 may be projected as shown in Table 6. The total estimated number of tears was 65.43, while the actual number was 76, a difference of approximately 14 percent. With a small margin of safety, a correction of 15 percent is considered reasonable.

Model for Mean Sorties Between Damage

25. By adjusting the constants in equations 3, 4, and 5 by 15 percent, so that

$$MSBD_E = 4.25(NS_E/NL)^3, \tag{6}$$

$$MSBD_C = 34(NS_C/NL)^3, \text{ and} \tag{7}$$

$$MSBD_T = 272(NS_T/NL)^3, \tag{8}$$

the expected number of tears can be made to match the actual number with a small margin of safety. The revised lines are drawn in Fig. 1 (solid lines) and appear to fit the scatter diagram about as well as the initial dotted lines.

26. In lieu of sufficient data for a statistical analysis, equations 6, 7, and 8 will be used with due caution to estimate the mean number of sorties between damage. It must be emphasized that these relationships were derived from experience with neoprene-coated nylon fabrics only. While they may be applicable to other materials with similar stress-strain characteristics, it is unlikely that these equations are applicable to a wide range of fabric materials and coatings. Also it should be noted that these relationships were derived for fixed-wing aircraft only, since there were insufficient data to develop a separate performance model for rotary-wing aircraft. It is anticipated, however, that MSBD's for helicopter wheel and skid loads during landing will be roughly equivalent to MSBD's for aircraft wheel loads during taxiing and maneuvering on the taxiway and parking areas. Thus, for helicopters, equation 8 will be used to compute MSBD.

Table 5

T-17 Membrane Performance in Vietnam

Aircraft	Sorties	Weight (lb)[1]	Tires in Main Gear	Tire Width	NL
0-1	94	2,400	2	5.95	101
U-10	26	3,600	2	5.95	151
U-6	22	5,100	2	7.4	172
C-45	4	7,500	2	9.5	197
U-1	7	8,000	2	9.5	210
U-8	28	7,700	2	7.4	260
CV-2	696	28,500	4	9.5	375
OV-1	90	12,700	2	7.4	428
C-47	2	30,000	2	14.8	506
C-123	38	48,000	2	14.7	816
C-130	216	130,000	4	17.1	950

[1]Assumption: Aircraft loaded as for support area medium lift airfield.

Table 6

Projected Membrane Performance

Aircraft	$\frac{NL}{NS}$	$\left[\frac{NL}{NS}\right]^3$	Sorties (S)	$S \cdot \left[\frac{NL}{NS}\right]^3$	Expected No. of Tears* Runway Ends $K=5$	Runway Centers $K=40$	Taxi-Park $K=320$
0-1	.106	.0012	94	0.112	0.02	-	-
U-10	.158	.0039	26	0.101	0.02	-	-
U-6	.180	.0058	22	0.128	0.03	-	-
C-45	.206	.0087	4	0.035	0.01	-	-
U-1	.220	.0106	7	0.074	0.01	-	-
U-8	.272	.0201	28	0.563	0.11	0.01	-
CV-2	.392	.0602	696	41.900	8.38	1.05	0.13
OV-1	.448	.0900	2	8.100	1.62	0.20	0.03
C-47	.530	.1490	90	0.298	0.06	0.01	-
C-123	.853	.6210	38	23.600	4.72	0.59	0.07
C-130	.994	.9820	216	212.000	42.40	5.30	0.66
					57.38	7.16	0.89
Total est. tears = 57.38+7.16+0.89 = 65.43							

$$\text{*No. of tears} = \frac{S}{MSBD} = \frac{S\left(\frac{NL}{NS}\right)^3}{K}.$$

Additional Notes on Mean Sorties Between Damage

27. Combined MSBD from equations 6, 7, and 8 is

$$\frac{1}{MO} = \frac{1}{MSBD_E} + \frac{1}{MSBD_C} + \frac{1}{MSBD_T}$$

$$= \frac{1}{4.25(NS_E/NL)^3} + \frac{1}{34(NS_C/NL)^3} + \frac{1}{272(NS_T/NL)^3} .$$

Let $NS_E = NS$, $NS_C = \alpha NS$, $NS_T = \beta NS$, so that

$$\frac{1}{MO} = \frac{1}{4.25(NS/NL)^3} + \frac{1}{34\alpha^3(NS/NL)^3} + \frac{1}{272\beta^3(NS/NL)^3}$$

$$= \left(\frac{1}{4.25} + \frac{1}{34\alpha^3} + \frac{1}{272\beta^3}\right)\left(\frac{NL}{NS}\right)^3 ,$$

or $$MO = \left(\frac{1}{\frac{1}{4.25} + \frac{1}{34\alpha^3} + \frac{1}{272\beta^3}}\right)\left(\frac{NS}{NL}\right)^3 . \tag{9}$$

28. For a single membrane used throughout the airfield,

$$\alpha = \beta = 1 \text{ or } NS_E = NS_C = NS_T , \tag{10}$$

and $$MO = 3.73(NS/NL)^3 . \tag{11}$$

29. For a three membrane system in which the membranes are placed so that each airfield area has the same rate of damage occurrence, we have

$$MSBD_E = MSBD_C = MSBD_T ,$$

or $$MO = \frac{MSPD_E}{3} = 1.42(NS/NL)^3 \tag{12}$$

and $$NS_C = \alpha NS_E = (4.25/34)^{1/3} NS_E = 0.5\ NS_E , \tag{13}$$

$$NS_T = \beta NS_E = (4.25/272)^{1/3} NS_E = 0.25\ NS_E . \tag{14}$$

30. In general, MO may be expressed as follows:

$$MO = K_O(NS/NL)^3 . \tag{15}$$

From equations 11 and 12, it is seen that a practical range for K_O is

$$1.42 \le K_O \le 3.73 . \tag{16}$$

31. For computations involving availability, only mean sorties between damage to the runway is considered, i.e.,

$$\frac{1}{MR} = \frac{1}{MSBD_E} + \frac{1}{MSBD_C}$$

$$= \left(\frac{1}{4.25} + \frac{1}{34\alpha^3}\right)\left(\frac{NL}{NS}\right)^3$$

$$MR = \left(\frac{1}{\frac{1}{4.25} + \frac{1}{34\alpha^3}}\right)\left(\frac{NS}{NL}\right)^3 . \tag{17}$$

32. If the same material is used for the entire runway, we have

$$NS_E = NS_C, \text{ or } \alpha = 1, \tag{18}$$

and $$MR = 3.78(NS/NL)^3 . \tag{19}$$

33. If two membranes are selected so that the mean sorties between damage for runway ends and centers are equal, then

$$MSBD_E = MSBD_C,$$

$$MR = \frac{MSBD_E}{2} = 2.13(NS/NL)^3, \tag{20}$$

and $$NS_C = \alpha NS_E = \left(\frac{4.25}{34}\right)^{1/3} NS_E = 0.5\ NS_E. \tag{21}$$

34. In general, MR may be expressed as

$$MR = K_R(NS/NL)^3. \tag{22}$$

From equations 19 and 20, it is seen that a practical range for K_R is

$$2.13 \leq K_R \leq 3.78. \tag{23}$$

DEFINITION OF MEMBRANE DUTY CLASSES

35. Membrane duty classes must be defined in terms of nominal tensile strength levels for each membrane system, as follows:

a) Heavy, medium, and light duty in a three-membrane system

b) Heavy and light duty in a two-membrane system

c) Heavy duty in a single membrane system.

36. For each class of airfield or heliport, the nominal tensile load (NL) applied by the critical aircraft was established and areas to be surfaced were cataloged for:

a) Runway ends (1/3 total runway length)

b) Runway centers (2/3 total runway length)

c) Other traffic areas (taxiways, parking, warmup areas).

37. The total weight per airfield for a given membrane system was estimated from an approximate relationship between membrane weight and nominal tensile strength for neoprene-coated nylon fabrics. From Fig. 2, WT = NS/3384. It is assumed that package and panel sizes will remain the same as those in current use. Membrane areas must be about 12-1/2 percent greater than airfield areas to allow for joining and anchoring (Ref. 7), and 10 percent must be added for replacement parts (Ref. 1). Membrane accessories, such as anchors, antiskid, adhesive, joining material, and packaging, contribute about 55 percent to the weight of the membrane. Thus, the total weight of a membrane system for a given airfield is

$$W = NS/3384 \times \text{Area} \times 1.125 \times 1.1 \times 1.55$$

$$= NS \times \text{Area}/1765,$$

or

$$W = (NS_E \times A_E + NS_C \times A_C + NS_T \times A_T)/1765$$

where subscripts E, C, and T represent runway ends, centers, and taxi-park areas.

38. Optimum nominal tensile strengths for one-, two-, and three-membrane systems were calculated to give QMR 24-hour availability, maintenance effort, and service life. Runway downtime, maintenance effort, and service life equations (see paragraphs 43, 56, and 63) were each solved for minimum MSBD. The largest of these three values was converted to

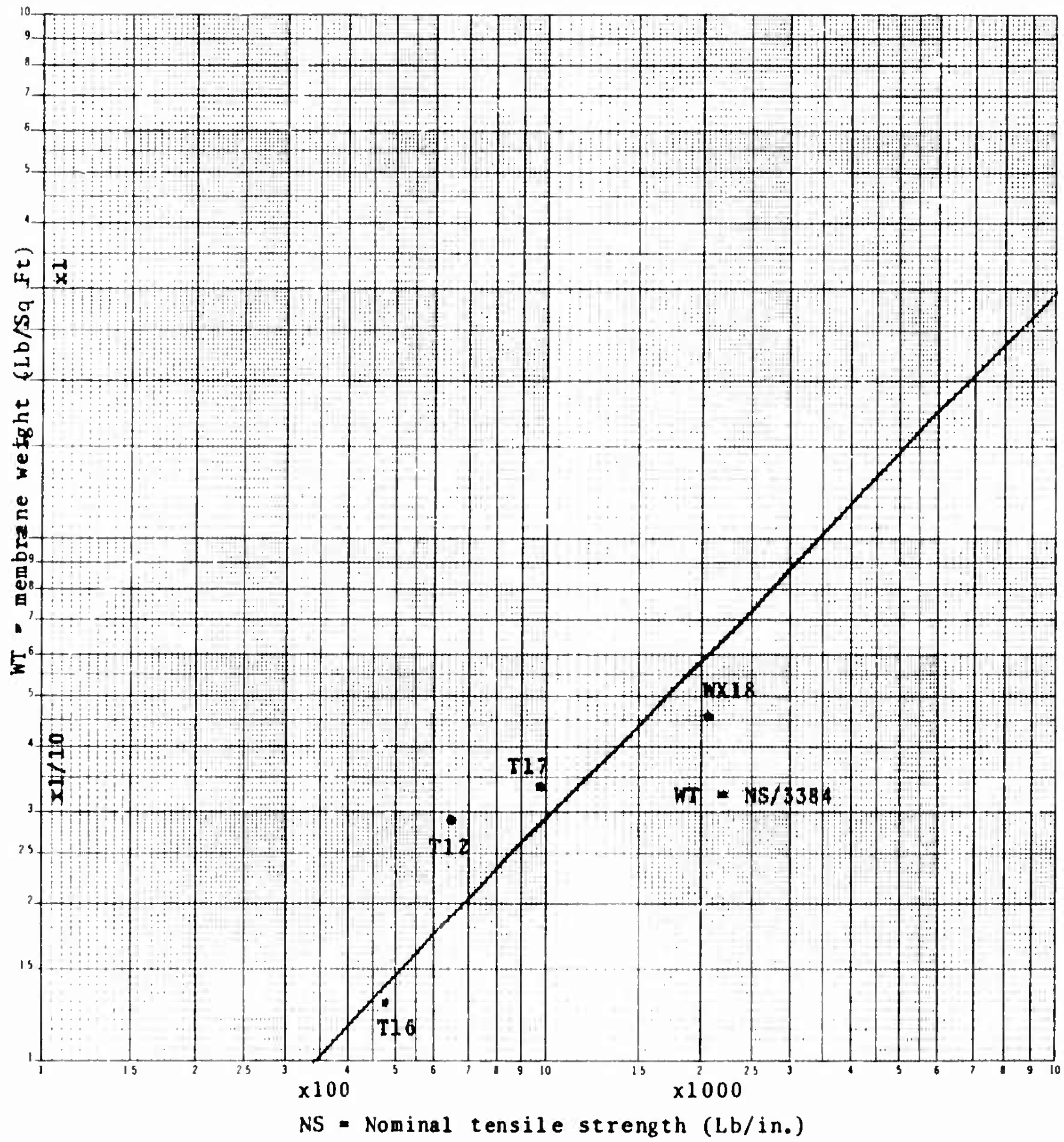

Figure 2. Relationship of membrane weight and tensile strength for neoprene-coated nylon fabric.

the required NS using the performance model from paragraph 25. This procedure was followed for each airfield class in each theater, and the matrix of results saved, i.e., nominal tensile strength, NS, for runway ends, runway centers, and other traffic areas.

39. In order to reduce the NS values (par. 38) to a manageable number, the matrix was grouped into NC numbered classes such that in each class

$$NS_{min} = 0.9\ NS_{max}.$$

By assigning NS_{max} as the value for each class, the weight per square foot, WT, was calculated for each class and the matrix of results, NC, NS, and WT, was saved.

40. The matrix of NS values (par. 38) was restored using NC such that $NS_{NC} \geq NS_{Required}$. The total weight of membrane and accessories was also calculated and the matrix of results, NC, W, saved.

41. Optional systems of one, two, and three membrane weights were generated, each within constraints of applicable NC from paragraph 40 as shown in Table 7. For each alternative in Table 7, the matrix in paragraph 40 was redone in terms of available classes (NC). The optimum 1, 2, and 3 membrane system was saved. For this suboptimization, it was assumed that the minimum total tonnage would approximate the minimum total cost. The actual application of each of the three optimum systems at each airfield type in each theater was then presented in tabular form along with the total tonnage of material required.

RUNWAY DOWNTIME, AVAILABILITY, AND INSPECTION FREQUENCY

42. The following assumptions regarding runway downtime, availability, and inspection were made:

a) Inspection frequency is a function of MSBD where S_0 = number of sorties between inspections (see "Inspection Frequency," par. 47-48).

b) Inspection for membrane damage may be made in one-pass along runway.

c) Inspection starts immediately after S_0 sorties.

d) Repair or inspection time for taxiways and parking areas does not decrease airfield availability.

Table 7

Optional Membrane Systems

NC	S_{1-1}	S_{2-1}	S_{2-2}	S_{2-3}	....	S_{2-n_2}*	S_{3-1}	S_{3-2}	S_{3-3}	....	S_{3-n_3}*
1		x					x	x	x		
2			x				x				
3				x				x			
4									x		
.		.					.				
.		.					.				
.		.									x
.						x					x
NC_{max}	x	x	x	x	....	x	x	x	x	....	x

$^*n_2 = m_2 - 1$

$n_3 = \frac{(m_3-1)(m_3-2)}{2}$

m_2 = no. membrane classes applicable to 2-membrane systems.

m_3 = no. membrane classes applicable to 3-membrane systems.

Mean Runway Downtime Per Sortie

43. Let D_T represent the mean total runway downtime per sortie, in hours, for a given membrane-surfaced airfield/aircraft/load. There are two distinct components of D_T, i.e.,

$$D_T = D_I + D_R \tag{24}$$

where D_I = mean runway downtime for inspection per sortie,

and D_R = mean runway downtime for repair per sortie.

D_I will be defined as

$$D_I = \left(\frac{L}{V \times N}\right) \times \frac{1}{S_0} \tag{25}$$

where L = length of runway, in feet,

V = inspection vehicle speed (ft/hr)

N = number of repair crews used simultaneously, also number of inspection-repair vehicles used simultaneously,

S_0 = number of sorties between inspections (see discussion of inspection frequency, par. 47-48);

and D_R will be defined as

$$D_R = \left(T_1 + \frac{T_2}{C \times N}\right) \times \left(\frac{1}{MSBD_E} + \frac{1}{MSBD_C}\right) \tag{26}$$

where T_1 = mean repair time unaffected by crew size (e.g., drying time of adhesives) in hr. per damage,

T_2 = mean man-hours of crew-related repair time per damage,

C = number of men in inspection-repair crew, per vehicle,

$MSBD_E$ = mean sorties between damage on runway ends (L/6 on each end),

$MSBD_C$ = mean sorties between damage on runway center (2L/3).

To simplify, let MR represent the mean number of sorties between damage to the membrane on the runway, i.e.,

$$MR = \frac{1}{\dfrac{1}{MSBD_E} + \dfrac{1}{MSBD_C}} . \tag{27}$$

Thus, from equations 24, 25, 26, and 27,

$$D_T = \frac{L}{V \times N} \times \frac{1}{S_0} + \left(T_1 + \frac{T_2}{C \times N}\right) \times \frac{1}{MR}. \tag{28}$$

<u>Runway Membrane Availability Per 24 Hours</u>

44. For a given membrane-covered airfield and critical aircraft, the membrane-related airfield availability may be conveniently expressed in terms of sorties per day and runway downtime per sortie, as

$$A = \left(1 - \frac{S \times D_T}{24}\right) \times 100 \tag{29}$$

where S = mean sorties per 24 hours.

45. The QMR states that $A \geq 93$ percent based on an average of seven sorties per day. To meet this requirement, the following inequality must be satisfied:

$$0 \leq D_T \leq 0.24 \text{ hr/sortie.}$$

It should be noted that repair or inspection time for taxiways, parking areas, and ground vehicle traffic areas does not decrease availability.

46. Reasonable values may be assigned to V, T_1, and T_2, based on test and field experience. L is known for a given airfield type. It will be shown later that S_0 is a function of MR. Equation 28 then relates the unknowns C, N, and MR. A sensitivity analysis will determine the relative influence of V, T_1, T_2, S_0, C, and N on MR while D_T is fixed at 0.24.

<u>Inspection Frequency</u>

47. In order to keep runway inspection time at a minimum, it would be useful to relate the frequency of inspections to the frequency of occurrence of membrane damage. Damage to T-17 membrane during C-130 operations at Ft. Campbell, Kentucky (Ref. 2), is summarized in Tables 8 and 9. The mean number of sorties between damage appears to follow a negative exponential distribution (NED), as shown in Fig. 3, i.e.,

$$f(x) = \frac{1}{MR} e^{-\frac{x}{MR}} \tag{30}$$

where $f(x)$ = relative frequency of occurrence of x sorties between damage,
x = number of sorties between damage,
MR = mean sorties between damage.

Table 8

Summary of T-17 Membrane Damage at Ft. Campbell, Ky.
During C-130 Operations, 2 Aug 65 to 10 Nov 65

Tear No.	Date (1965)	Time	T-130 Aircraft: Weight (1000 lb)	T-130 Aircraft: Function[1]	Tear Location[2]: Position	Tear Location[2]: Panel	No. of Sorties[3]: Accumulated	No. of Sorties[3]: Between Tears
1	2 Aug	1145	103.6	TD	E	30	1	1
2	3 Aug	1103	110.5	BR	E	27	9	8
3	5 Aug	2035	103.5	TD	E	2	34	25
4	5 Aug	2044	103.5	BR	C	18	35	1
5	5 Aug	2053	102.5	BR	C	19	36	1
6	6 Aug	1045	115.0	TD	E	29	37	1
7	9 Aug	1130	115.5	TD	E	2	62	25
8	9 Aug	1202	113.5	TD	E	2	66	4
9	9 Aug	1224	113.5	TR	E	5	66-1/2	1/2*
10	10 Aug	1213	119.0	TD	E	2	90	23-1/2*
11	10 Aug	1250	119.0	RU	E	2	91	1
12	10 Aug	1427	112.7	TD	E	2	97	6
13	10 Aug	1427	112.7	TD	E	2	97	0*
14	19 Aug	1730	109.0	TD	E	2	106	9
15	19 Aug	1840	106.0	TD	E	2	110	4
16	23 Aug	1411	127.5	TD	E	29	116	6
17	23 Aug	1421	127.5	TD	E	28	119	3
18	23 Aug	1714	125.0	TD	E	31	124	5
19	23 Aug	1714	125.0	TD	E	31	124	0*
20	23 Aug	--	125.0	LR	C	25	126	2
21	23 Aug	--	125.0	BR	C	23	126	0*
22	24 Aug	--	125.0	TD	E	30	137	11
23	24 Aug	--	125.0	TD	E	27	137	0*
24	24 Aug	--	125.0	TD	E	30	141	4
25	24 Aug	--	125.0	BR	E	30	141-1/2	1/2*
26	25 Aug	1721	125.0	TD	E	29	157	15-1/2*
27	25 Aug	1743	125.0	RU	E	29	157-1/2	1/2*
28	4 Oct	1420	110.0	TD	E	2	173	15-1/2*
29	4 Oct	1712	113.0	TD	E	3	176	3
30	4 Oct	1723	95.0	TD	E	4	179	3
31	5 Oct	1130	120.0	RU	E	2	186-1/2	7-1/2*
32	5 Oct	1202	125.0	TD	E	4	188	1-1/2*
33	6 Oct	1215	116.0	TD	E	29	211	23
34	7 Oct	1815	116.0	TD	E	28	228	17
35	10 Nov	--	96.0	TD	E	3	239	11
36	10 Nov	--	96.0	TD	E	3	241	2
37	10 Nov	--	96.0	TD	E	4	244	3

*When two tears occur during one landing or one takeoff, the second tear is considered as 0 sorties between tears. If one tear occurs on landing and another on takeoff, the second tear is considered as 1/2 sortie between tears.

[1] TD = Touchdown
LR = Landing Roll
BR = Braking
ST = Steering
RU = Engine Runup
TR = Takeoff Roll

[2] Position — Panel
End — 1-5
Center — 6-26
End — 27-31

[3] 1 sortie = 1 takeoff + 1 landing, or 1 landing if not accompanied by a takeoff.
1/2 sortie = 1 takeoff

Table 9

Frequency Distribution of T-17 Membrane Damage

No. of Sorties Between Damage	Frequency	Relative Frequency (%)
0	4	10.6
1/2	3	7.9
1	5	13.2
1-1/2	1	2.6
2	2	5.3
3	4	10.6
4	3	7.9
5	1	2.6
6	2	5.3
7-1/2	1	2.6
8	1	2.6
9	1	2.6
11	2	5.3
15	1	2.6
16	1	2.6
17	1	2.6
23	1	2.6
23-1/2	1	2.6
25	2	5.3
44+	1	2.6
	38	100.0

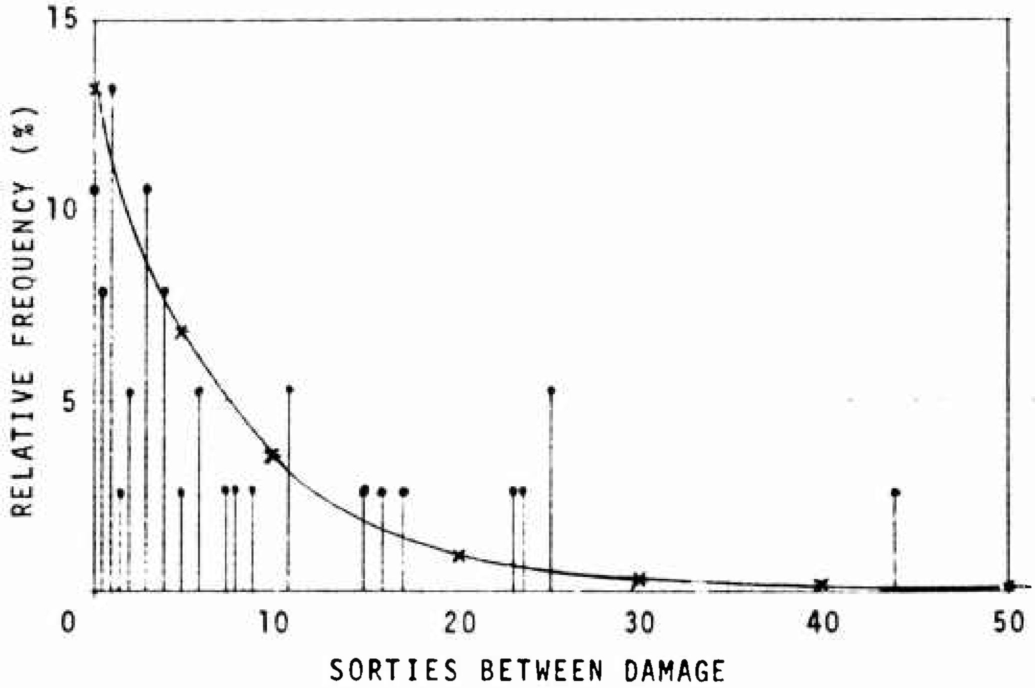

Figure 3. Frequency distribution of sorties between damage for T17 membrane at Ft. Campbell, Ky.

The cumulative distribution function is

$$F(S_0) = \frac{1}{MR}\int_0^{S_0} e^{-\frac{x}{MR}}\,dx = 1-e^{-\frac{S_0}{MR}}. \tag{31}$$

The function $F(S_0)$ gives the probability that a damage has occurred in S_0 sorties. For example, the probability that damage has occurred by the time S_0 equals MR sorties is

$$F(MR) = 1 - e^{-1} = 0.632, \text{ or } 63.2 \text{ percent.}$$

48. The survivor function,

$$\mathcal{F}(S_0) = 1 - F(S_0) = e^{-\frac{S_0}{MR}}, \tag{32}$$

gives the probability that no damage has occurred in S_0 sorties.

Let $p = \mathcal{F}(S_0) = e^{-\frac{S_0}{MR}}$.

Solving for S_0, we have (33)

$$S_0 = \ell n(1/p) \times MR.$$

49. By using an inspection policy of S_0 sorties between inspection in a situation where the mean sorties between damage is MR, the probability that no damage has occurred in S_0 sorties is p. Keeping in mind the risk of a small tear developing into a failure (as defined in the QMR) if not repaired immediately, a conservative policy might be to set $p = 0.9$, i.e., the probability that no damage has occurred since the last inspection is 90 percent, or

$$S_0 = 0.105MR. \tag{34}$$

This inspection policy will be adopted for the present study with the following restrictions. In practice, S_0 must be equal to or greater than 1 sortie per inspection, with a minimum of one inspection per day, i.e.,

$$1 \leq S_0 \leq S. \tag{35}$$

If an inspection is made after <u>each</u> sortie, the probability of no damage may be less than 90 percent, provided that QMR availability, maintenance effort, and service life are met.

50. From the results of the T-17 tests under the C-130 at Fort Campbell (Ref. 2), the probability of no damage after each sortie was

$$p = e^{-\frac{S_0}{MR}} = e^{-\frac{1}{7.8}} = 0.87, \text{ or } 87 \text{ percent.}$$

Thus an inspection should be performed after each sortie for a C-130 operating on T-17 covered runways. This checks with field experience in Vietnam (Ref. 6).

Downtime Per Damage

51. By combining equations 28 and 33, we have

$$D_T = \left[\frac{L}{V \times N \times \ell n(1/p)} + \left(T_1 + \frac{T_2}{C \times N}\right)\right]\frac{1}{MR}. \qquad (36)$$

Let the mean downtime per damage be D_D. Then

$$D_T = \frac{D_D}{MR} \qquad (37)$$

where $$D_D = \frac{L}{V \times N \times \ell n(1/p)} + T_1 + \frac{T_2}{C \times N}. \qquad (38)$$

MAINTENANCE MAN-HOURS

52. The following assumptions pertain to maintenance man-hours:

a) Maintenance man-hours are counted while actually working on maintenance, but include time to get to job.

b) Maintenance includes inspection and membrane repair only.

c) Membrane damage is repaired immediately after it is found.

d) Inspection of taxiways and parking areas is done at least once per 24 hours.

Runway Inspection Man-Hours

53. Mean man-hours per sortie for runway inspection, MMH_I, may be expressed as follows:

$$MMH_I = \left(T_3 + \frac{L}{V \times N}\right) \times \frac{1}{S_0} \times C \times N, \qquad (39)$$

also $$MMH_I = \left(\frac{T_3}{S_0} + D_I\right) \times C \times N, \qquad (40)$$

where L, V, N, S_0, D_I are defined in paragraph 43, and T_3 = time to and from runway.

Runway Repair Man-Hours

54. Mean man-hours per sortie for runway repairs (MMH_R) is calculated as follows:

$$MMH_R = \frac{T_2}{MR}, \tag{41}$$

also $$MMH_R = \left[D_R - \frac{T_1}{MR}\right] \times C \times N, \tag{42}$$

where T_2, D_R, and MR are defined in paragraph 43.

Non-Runway Traffic Area Inspection and Repair

55. Mean man-hours per sortie for inspection and repair of traffic areas other than runways, MMH_T, is calculated as follows:

$$MMH_T = \frac{L_T}{V \times N} \times \frac{1}{S_1} \times C \times N + \frac{T_2}{MSBD_T}, \tag{43}$$

where V, N, T_2, C are defined in paragraph 43.

and L_T = distance, in feet, traveled during inspection of taxiway, warmup and park areas,

$MSBD_T$ = mean sorties between damage to membrane on taxi, warmup, park areas.

$$S_1 = MSBD_T \, \ln(1/p), \tag{44}$$

where S_1 is number of sorties per inspection with probability of no damage equal to p (initially p = 0.9), provided that a minimum of one inspection per day is required, i.e.,

$$1 \leq S_1 \leq S.$$

Total Maintenance Man-Hours

56. Mean total maintenance man-hours per sortie, MMH, for a given membrane-surfaced airfield/aircraft/load is obtained as follows:

$$MMH = MMH_I + MMH_R + MMH_T. \tag{45}$$

The QMR requires that total maintenance man-hours must not exceed 150 per month. The average number of sorties per month is given as 200, thus

$$MMH \leq \frac{150}{200} = 0.75 \text{ man-hour/sortie.}$$

From equations 39, 41, 43, and 45,

$$MMH = \left[\frac{T_3}{S_0} + \frac{1}{V \times N}\left(\frac{L}{S_0} + \frac{L_T}{S_1}\right) + \frac{1}{MO}\left(\frac{T_2}{C \times N}\right)\right] \times C \times N \qquad (46)$$

where

$$\frac{1}{MO} = \frac{1}{MR} + \frac{1}{MSBD_T} = \frac{1}{MSBD_E} + \frac{1}{MSBD_C} + \frac{1}{MSBD_T} \qquad (47)$$

In equation 46, L and L_T are known for each airfield type, V, T_2, and T_3 can be assigned from current experience. $S_0 = f(MR)$, and $S_1 = f(MSBD_T)$, and $MMH \leq 0.75$. The equation then relates the unknowns C, N, MO. From equations 40, 43, 45, and 24, MMH may also be expressed as

$$MMH = \left[\frac{T_3}{S_0} - \frac{T_1}{MR} + D_T\right] \times C \times N + MMH_T. \qquad (48)$$

From the QMR criteria for maintenance man-hours and availability,

$$MMH_{(max)} = 0.75 \qquad (49)$$

$$D_{T(max)} = 0.24. \qquad (50)$$

PLACEMENT RATE

57. Placement rate may be expressed in terms of equivalent sorties. Let

PR_E = placement rate on runway ends (sq ft/man-hr)
PR_C = placement rate on runway center (sq ft/man-hr)
PR_T = placement rate on taxiway, warmup and park area (sq ft/man-hr)
A_E = area of runway ends (sq ft)
A_C = area of runway center (sq ft)
A_T = area of taxiway, warmup, park (sq ft)
PC = number of men per crew
N = number of crews working simultaneously
S = average number of sorties per day
PRS = placement rate for airfield expressed in terms of equivalent sorties (i.e., the normal number of sorties which could have been made during the time required for placement of membrane).

$$PRS = \left[\frac{A_E}{PR_E} + \frac{A_C}{PR_C} + \frac{A_T}{PR_T}\right]\left[\frac{S}{24xPCxN}\right]. \tag{51}$$

A typical value of 7 sorties per day may be assigned to S (Ref. 1). Airfield areas are known for a given airfield and from paragraph 19-n it is recalled that

$$A_C = 2A_E. \tag{52}$$

From current experience with membrane placement (Ref. 2,3,7, 8,9) it appears that the placement crew should consist of one or two Engineer platoons (about 35 men each).

58. If a single membrane weight is used throughout an airfield, equation 51 reduces to

$$PRS = \frac{AAxS}{PR_E x24xPCxN} \tag{53}$$

where $AA = A_E + A_C + A_T$

and $PR_E = PR_C = PR_T$.

59. For a two-membrane system with heavy material on runway and lighter material on non-runway areas, equation 51 is

$$PRS = \left[\frac{3A_E}{PR_E} + \frac{A_T}{PR_T}\right]\left[\frac{S}{24xPCxN}\right] \tag{54}$$

since $PR_E = PR_C$.

60. For a two-membrane system with heavy material on runway ends and light material on all other traffic areas, equation 51 becomes

$$PRS = \left[\frac{A_E}{PR_E} + \frac{A_C+A_T}{PR_C}\right]\left[\frac{S}{24xPCxN}\right] \tag{55}$$

since $PR_C = PR_T$.

61. The QMR gives essential and desired placement rates and weights for heavy, medium, and light duty membranes. These values are plotted in Fig. 4, along with values obtained by actual field placement of several membrane types*

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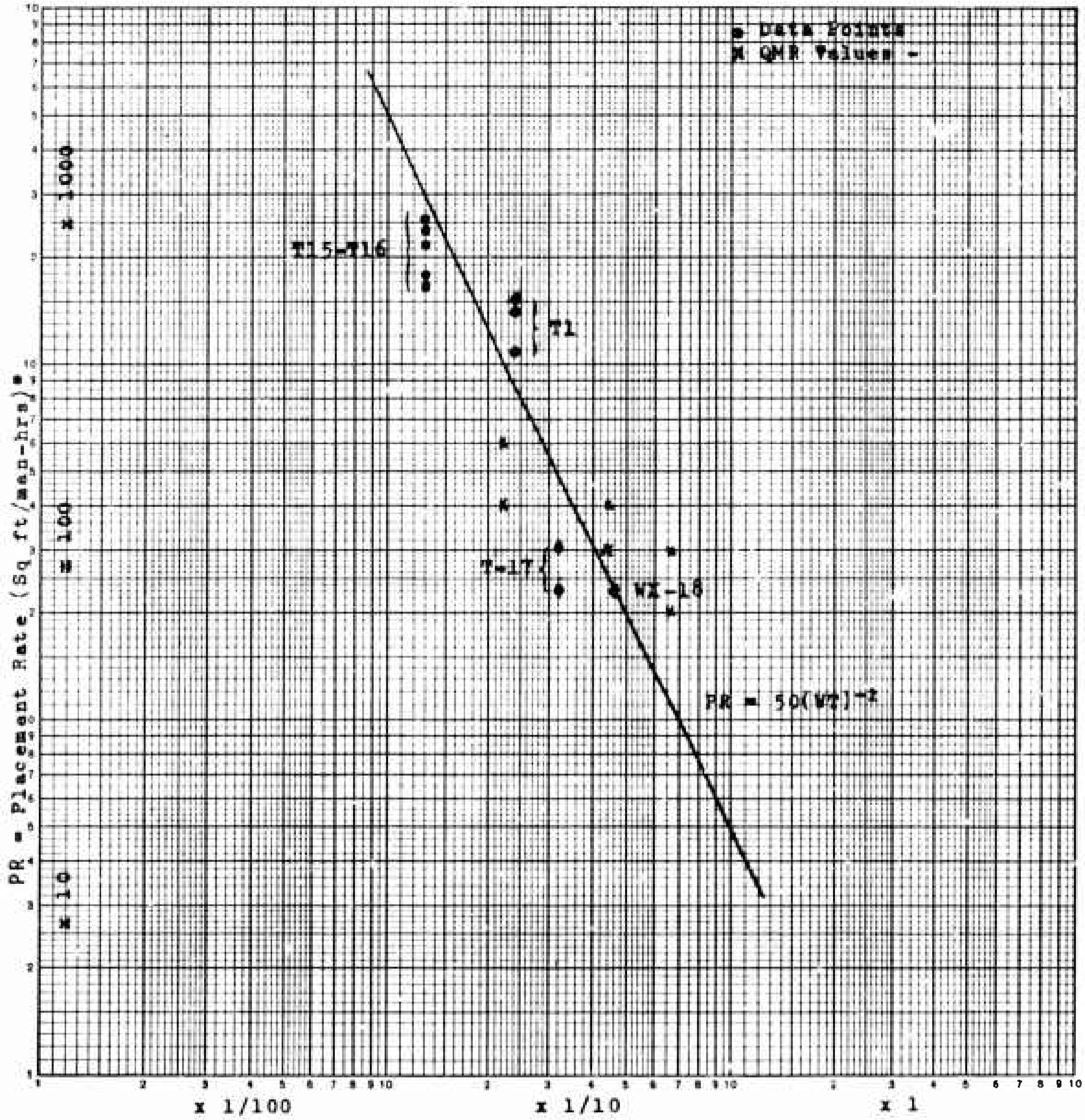
*Airfield construction, except for that related directly to membrane placement (e.g., anchor ditches), and field application of antiskid compounds are not included. It is assumed that factory-applied antiskid compounds will be used.



WT = Membrane Weight (lb/sq ft)
*(Equipment operator man-hours included)

Figure 4. Relationship of placement rate and membrane weight.

(Ref. 2,3,9,10,11,12,14). An approximate relationship between placement rate and membrane weight per square foot is given by

$$PR = 50/WT^2. \tag{56}$$

By substitution of equation 56 into equation 51, 52, 53, 54, and 55, placement rates (in equivalent sorties) may be expressed as a function of airfield area and membrane weight, for a given S, PC, and N.

$$PRS = \left[A_E \times WT_E{}^2 + A_C \times WT_C{}^2 + A_T \times WT_T{}^2\right]\left[\frac{S}{1200 x PC x N}\right]. \tag{57}$$

62. Since membrane duty classes will be defined in terms of membrane strength instead of weight, and since an optimum family of membranes may not correspond to the heavy, medium, and light duty classes proposed in the QMR, a rule must be established for comparison of predicted placement rates with QMR placement rates. If a trial membrane system consists of a single membrane, its placement rate will be compared to the QMR heavy duty placement rate; placement rates for a two-membrane system will be compared with the QMR heavy and light duty placement rates; and for a three-membrane system the comparison is obvious.

SERVICE LIFE

63. The service life of a membrane on a given airfield is defined as the number of sorties required to cause the total area of membrane of that type used for repairing to exceed 10 percent of the airfield traffic area covered by membrane of that type. Let

PA_E = average amount of membrane required to repair a damage on runway ends (sq ft)
PA_C = average amount of membrane required to repair a damage on runway centers (sq ft)
PA_T = average amount of membrane required to repair a damage on taxiway, warmup and parking areas (sq ft)
SL_E = service life of runway ends (sorties)
SL_C = service life of runway centers (sorties)
SL_T = service life of taxiway, warmup and parking areas (sorties)
S = average number of sorties per day
$MSBD_{E,C,T}$ defined previously

K_p = multiplier to determine the amount of membrane to be initially supplied to the airfield to repair membranes in accordance with the QMR; this will be set at $K_p = 0.1$.

Then
$$SL_E = K_p \times \frac{A_E x MSBD_E}{PA_E} \tag{58}$$

$$SL_C = K_p \times \frac{A_C x MSBD_C}{PA_C} \tag{59}$$

$$SL_T = K_p \times \frac{A_T x MSBD_T}{PA_T}. \tag{60}$$

(Note that $A_C = 2A_E$ from par. 19.)

64. The QMR states that service life must be at least 1200 sorties ($\simeq 7$ per day for 6 months), thus

$$SL_E \geq SLQ, \quad SL_C \geq SLQ, \quad SL_T \geq SLQ \tag{61}$$

$$MSBD_E \geq \frac{SLQ x PA_E}{K_p x A_E} \tag{62}$$

$$MSBD_C \geq \frac{SLQ x PA_C}{K_p x A_C} \tag{63}$$

$$MSBD_T \geq \frac{SLQ X PA_T}{K_p x A_T} \tag{64}$$

where SLQ = QMR service life (initially set at 1200).

65. From paragraph 25, the mean sorties between damage may be expressed as

$$MSBD = K_m \left[\frac{NS}{NL}\right]^3, \tag{65}$$

and from Fig. 5, the patch area per damage may be expressed as

$$PA = 55 \times \frac{NL}{NS}. \tag{66}$$

Thus,
$$\frac{NS}{NL} \geq \left[\frac{SLQ x 55}{K_p x K_m x A}\right]^{1/4} \tag{67}$$

where A is the area of an airfield or portion of an airfield to be surfaced and NS is the corresponding membrane strength required for the QMR service life, SLQ.

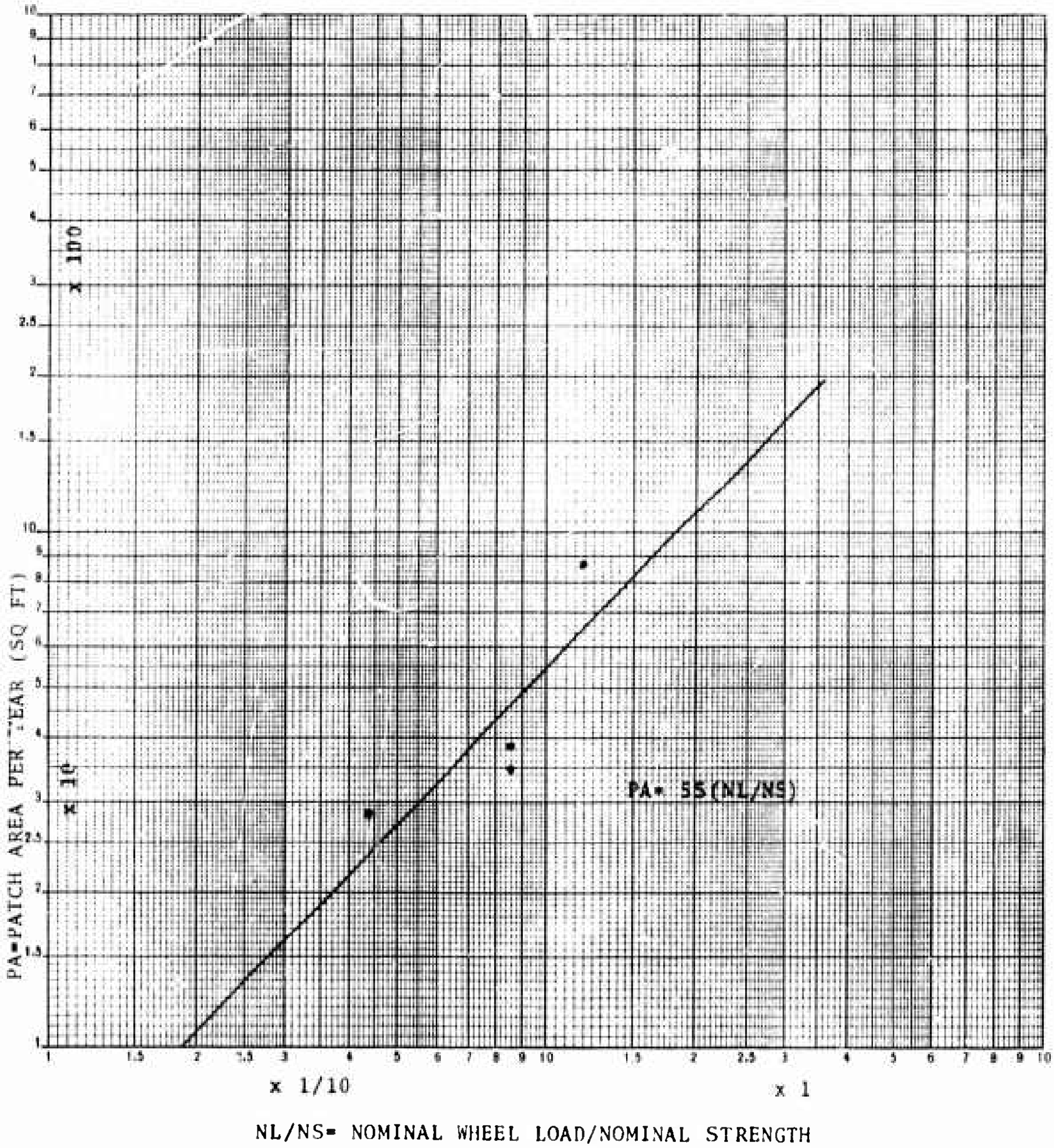


Figure 5. Relationship of patch area per tear and load to strength ratio.

66. Membrane effectiveness is a function of availability, placement rate, and service life (see par. 18). Nominal tensile strengths for membranes will be selected to provide a minimum availability of 93 percent at 7 sorties per day, maximum maintenance effort of 150 man-hours per 200 sorties, and minimum service life of 1200 sorties with 10 percent replacement parts as required by the QMR. Placement rate will be dependent upon the membrane weight corresponding to the minimum tensile strength required (see par. 57).

Availability

67. The primary measure of effectiveness is the average 24-hour availability which will be assigned a weight of 70 percent.

68. Availability greater than 93 percent for 7 sorties per 24 hours may be expressed as sorties per day which can be supported at 93 percent availability, i.e.,

$$SS = \frac{24}{D_T}\left[1 - \frac{AQ}{100}\right] \tag{68}$$

where D_T = mean downtime per sortie (see eq. 28)
AQ = QMR availability (93 percent)
SS = mean sorties per day.

While modest increases in availability above the minimum 93 percent appear to be desirable (e.g., to accommodate unexpected peaks in traffic volume), it does not seem appropriate to assign unlimited effectiveness to increased availability if the QMR value is at all realistic. Thus, availability of 7 sorties at 93 percent will be credited with an effectiveness of 1.0 while excess availability will be credited at a decreasing rate to a maximum effectiveness of 2.0 according to the fol'owing formula:

$$E_{AV} = 2\left[1 - 2^{-\frac{SS}{S}}\right] \quad \text{for } SS \geq S \tag{69}$$

where S = QMR sorties per day (7) at 93 percent availability
SS = sorties attainable at 93 percent availability
E_{AV} = availability component of effectiveness.

Availability less than that required by the QMR will be charged off as a linear ratio, i.e.,

$$E_{AV} = \frac{SS}{S} \quad \text{for } SS \leq S. \tag{70}$$

66. Membrane effectiveness is a function of availability, placement rate, and service life (see par. 18). Nominal tensile strengths for membranes will be selected to provide a minimum availability of 93 percent at 7 sorties per day, maximum maintenance effort of 150 man-hours per 200 sorties, and minimum service life of 1200 sorties with 10 percent replacement parts as required by the QMR. Placement rate will be dependent upon the membrane weight corresponding to the minimum tensile strength required (see par. 57).

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SS = sorties attainable at 93 percent availability
E_{AV} = availability component of effectiveness.

Availability less than that required by the QMR will be charged off as a linear ratio, i.e.,

$$E_{AV} = \frac{SS}{S} \quad \text{for } SS \leq S. \qquad (70)$$

Placement Rate

69. Placement rate will be weighted 20 percent.

70. Time required for placement of membrane will be converted to sorties lost at the rate of 7 per day. From equation 51, placement rate in terms of total sorties lost is:

$$PRS = \left[\frac{A_E}{PR_E} + \frac{A_C}{PR_C} + \frac{A_T}{PR_T}\right] \frac{S}{24xPCxN}. \tag{71}$$

The permissible number of sorties lost based on QMR placement rates may be calculated as follows:

$$PRSQ = \left[\frac{A_E}{PRQ_E} + \frac{A_C}{PRQ_C} + \frac{A_T}{PRQ_T}\right] \frac{S}{24xPCxN}. \tag{72}$$

71. Placement rates above and below the QMR rates will be charged off as a linear ratio, i.e.,

$$E_{PR} = \frac{PRSQ}{PRS}. \tag{73}$$

Service Life

72. Service life will be weighted 10 percent.

73. From equations 58, 59, 60, 65, and 66, service life may be calculated as follows:

$$SL_E = \frac{0.425xA_E}{55.} x \left[\frac{NS}{NL}\right]^4 \tag{74}$$

$$SL_C = \frac{3.4xA_C}{55.} x \left[\frac{NS}{NL}\right]^4 \tag{75}$$

$$SL_T = \frac{27.2xA_T}{55.} x \left[\frac{NS}{NL}\right]^4. \tag{76}$$

Since the effectiveness of the membrane system is desired, the average service life for the airfield will be used, i.e.,

$$SL = \frac{SL_E+SL_C+SL_T}{3}. \tag{77}$$

74. Since the QMR service life for membrane is greater than anticipated airfield service life in all cases (except heliports), there is no appreciable gain from having increased service life, except higher recovery value or lower cost. The recovery value is accounted for in the cost model. Thus, the maximum effectiveness due to service life will be limited to 1.0, i.e.,

$$E_{SL} = 1.0. \tag{78}$$

75. Service life less than the QMR value will be charged off as a linear ratio, i.e.,

$$E_{SL} = \frac{SL}{SLQ}. \tag{79}$$

A Model for Effectiveness

76. The three components of effectiveness, which are basically incommensurable, have been placed on a comparable basis by converting availability and placement rate to equivalent sorties (service life is expressed in sorties). Since different orders of magnitude are involved (e.g., availability should be of the order of 10 sorties, placement rate may approach 100, and service life will be over 1000), each component has been normalized by dividing by the corresponding QMR value. Finally, an importance value (weighting factor) has been assigned to each component. Thus, the overall effectiveness of a membrane system on a given airfield is given by:

$$EFF = \frac{W_{AV} \times E_{AV} + W_{PR} \times E_{PR} + W_{SL} \times E_{SL}}{W_{AV} + W_{PR} + W_{SL}} \tag{80}$$

where W_{AV} = weighting factor for availability = 7
W_{PR} = weighting factor for placement rate = 2
W_{SL} = weighting factor for service life = 1
E_{AV} is defined in equation 69 or 70
E_{PR} is defined in equation 73
E_{SL} is defined in equation 78 or 79.

The constraints indicated by equations 69 and 70, and 78 and 79 must be taken into account when applying equation 80. When each component of effectiveness is equal to its corresponding QMR value, the overall effectiveness of the system will be equal to 1.0. Because of the constraints discussed above, maximum effectiveness will be approximately 2.0, depending on the contribution from placement rate. Minimum effectiveness could theoretically be zero, although

designing for QMR availability and service life will limit minimum effectiveness to about 0.8 to 0.9, depending on placement rates.

THEATER OF OPERATIONS MODEL

77. A model of a theater of operations is needed to define the requirements for membrane duty classes in terms of planned use, to define the required quantities of each, and to define membrane transportation distances.

78. After consultations with USACDC, data were assembled from various sources for five different theaters of operation corresponding to the five theater scenarios currently being considered by USACDC. These data are presented in Table 10.

79. The temperature and elevation data in Table 10 were used to adjust the sea-level dimensions for airfields as described in TM 5-366 (Ref. 7). The adjustment formula is:

$$L_{adj} = L \times \left[1 + \frac{T-59}{300}\right]\left[1 + \frac{E-1000}{10000}\right]$$

where L_{adj} = adjusted length of runway or taxiway

L = sea-level length of runway or taxiway

T = mean max temperature of warmest month (0°F); if less than 59°F, use 59°

E = elevation of airfield above sea level (ft); if less than 1000 ft, use 1000.

No adjustments were made to warmup aprons, parking areas, or helipads. Sea-level dimensions and adjusted areas of airfields and heliports are given in Table 11. All areas have been increased by 12-1/2 percent to permit anchoring and joining.

80. Additional airfield data on anticipated airfield life, critical aircraft and wheel loading, and surfacing policy are presented in Table 12 (Ref. 7,8,21,22).

81. Distances were determined for both air and surface mode of transportation. Three different points of origin -- the factory locations of three major suppliers of membrane -- were considered. Air and land distances are in statute miles while sea distances are in nautical miles. For the surface mode, in cases where COMMZ was not accessible by ship, transportation from the nearest friendly seaport to COMMZ was considered to be by air.

Table 10

Theater Scenario Data

Theater Identification No.	1	2	3	4	5
Mean Max Temp. Warmest Month (0°F)	67	75	85	85	52
Mean Elevation of Airfields (ft)	110	1000	7	4000	12000
Areal Extent of Theater					
Length (mi)	400	100	75	65	70
Width (mi)	250	40	75	65	70
Number of Airfields					
Battle Area Medium Lift (BAML)	0	0	4	0	0
Forward Area Medium Lift (FAML)	12	6	3	4	3
Support Area Medium Lift (SAML)	3	2	1	1	1
Rear Area Heavy Lift (RAHL)	6	4	1	2	1
Rear Area Tactical (RAT)	3	2	1	2	1
Number of Heliports					
Forward Area CH-47 (FAH)	47	39	13	56	13
Membrane Shipping Distances (mi)					
Origin 1 to CONUS Port by Air	1180	1700	1700	1180	300
Origin 1 to CONUS Port by Truck	1410	2040	2040	1410	330
Origin 2 to CONUS Port by Air	350	2440	2440	350	870
Origin 2 to CONUS Port by Truck	470	2980	2980	470	900
Origin 3 to CONUS Port by Air	590	2000	2000	590	810
Origin 3 to CONUS Port by Truck	710	2330	2330	710	930
CONUS to COMMZ by Air	4000	5850	8400	6300	4450
CONUS to COMMZ - 1st leg by Ship*	3650	5700	7550	5000	1450
CONUS to COMMZ - 2nd leg by Air	0	0	0	1300	2000

*Nautical miles

Table 11

Membrane Requirements for Airfields

Theater	Airfield Position	FAH	BAML	FAML	SAML	RAHL	RAT
		Sea-Level Dimensions (ft) for Airfield Traffic Areas*					
	Runway	1200x300	2000x60	2500x60	3500x60	10000x156	8000x108
	Taxiway	-	2000x30	2500x30	3500x36	10000x60	8000x60
	Warmup	-	432x94	432x94	432x94	1000x94	1000x94
	Parking	-	-	600x150	2400x156	1740x960	1236x444
		Area of Membrane Required (sq ft)					
1	Runway	405,000		173,250	242,550	1,801,800	997,920
	Taxiway	---		86,630	145,530	693,000	554,400
	Warmup	---		45,680	45,680	105,750	105,750
	Parking	---		101,250	421,200	1,879,200	617,380
	TOTAL	*405,000*		*406,810*	*854,960*	*4,479,750*	*2,275,450*
2	Runway	405,000		177,750	248,850	1,848,600	1,023,840
	Taxiway	---		88,880	149,310	711,000	568,800
	Warmup	---		45,680	45,680	105,750	105,750
	Parking	---		101,250	421,200	1,879,200	617,380
	TOTAL	*405,000*		*413,560*	*865,040*	*4,544,550*	*2,315,770*
3	Runway	405,000	146,700	183,380	256,730	1,907,100	1,056,240
	Taxiway	---	73,350	91,690	154,040	733,500	586,800
	Warmup	---	45,680	45,680	45,680	105,750	105,750
	Parking	---	---	101,250	421,200	1,879,200	617,380
	TOTAL	*405,000*	*265,730*	*422,000*	*877,650*	*4,625,550*	*2,366,170*
4	Runway	405,000		238,390	333,740	2,479,230	1,373,110
	Taxiway	---		119,190	200,250	953,550	762,840
	Warmup	---		45,680	45,680	105,750	105,750
	Parking	---		101,250	421,200	1,879,200	617,380
	TOTAL	*405,000*		*504,520*	*1,000,870*	*5,417,730*	*2,859,080*
5	Runway	405,000		354,380	496,130	3,685,500	2,041,200
	Taxiway	---		177,190	297,680	1,417,500	1,134,000
	Warmup	---		45,680	45,680	105,750	105,750
	Parking	---		101,250	421,200	1,879,200	617,380
	TOTAL	*405,000*		*678,500*	*1,260,690*	*7,087,950*	*3,898,330*

*See Table 10 for airfield abbreviations. All areas, except heliports (FAH), have been adjusted for temperature and elevation given in Table 10, and all have been increased by 12-1/2 percent for anchoring and joining.

Table 12

Airfield Service Data

Type of Field[1]	Anticipated Service Life Days	Anticipated Service Life Sorties[2]	Surfacing	Critical Aircraft	Gross Weight (lb)	Tire Width (in)	No. Tires[3]	Nominal Tensile Load[4] (lb/in)
AIRFIELD								
BAML	3	21	none	C-123	48,000	15.1	2	795
FAML	14	98	membrane	C-130	110,000	17.5	4	785
SAML	60	420	membrane	C-5A	769,000	14.5	24	1110
RAHL	365	13,140	mat/membrane	C-141	318,000	13.7	8	1450
RAT	365	13,140	mat/membrane	F-101	52,000	7.9	2	1650
HELIPORT						Skids		
FAH	90	5,400	membrane	UH-1D	9,500	1.5	2	1585

[1]See Table 10 for airfield abbreviations.

[2]Anticipated service life in sorties is based on 7 sorties per day except for mat-covered fields which have 36 per day, and heliports which have 60 per day (based on UH-1D helicopter company with 80% availability).

[3]Main gear only.

[4]For coefficient of friction = 0.5.

82. Average intratheater air distances (from COMMZ to a particular airfield) were calculated from theater length (Table 10) in the following manner:

a) COMMZ to Battle Area = theater length
b) COMMZ to Forward Area = 3/4 theater length
c) COMMZ to Support Area = 1/2 theater length
d) COMMZ (Rear Area) = 1/4 theater length.

Trucking distances were obtained by multiplying air distances by 1.25.

83. The decision to use membrane, mat over membrane, or no surfacing at all, was based on the anticipated life of the field. Battle area airfields with a 3-day life were left bare, forward area (2-week) and support area (2-month) airfields and forward area (3-month) heliports were considered to be membrane covered, and rear area heavy lift and tactical fields with a 1-year life expectancy were assumed to be surfaced with mat over membrane.

84. It is anticipated that a mix of CH-47 and UH-1D aircraft will be using the forward area heliports. Therefore, the areal dimensions are based on the larger CH-47 and the applied loads are based on the aggressive skids of the UH-1D.

COST MODEL

Assumptions

85. The following assumptions regarding the cost model were made:

a) The total of R&D plus product improvement costs will be basically insensitive to the number of categories of membrane finally selected; i.e., this cost is common to all candidates and may be neglected.

b) Treat supplementary equipment and supplies (adhesive, anchors, patches, etc.) as percentage of membrane weight and percentage of membrane cost, based on current experience.

c) Use theater models to establish relative amounts of heavy, medium, and light, or heavy and light, or heavy membrane, and shipping distances from origin to CONUS port, CONUS to COMMZ, and COMMZ to field.

d) Assume all airfields required by theater model are one-year requirement, and charge all costs to first year.

e) Shipping costs in $/ton-mile for overseas air, ship, intrazone air and truck, will be based on current planning rates.

Basic Life-Cycle Cost Elements

86. The following cost elements were considered during the life cycle of a membrane:

a) Initial membrane costs per square foot (including factory-applied antiskid).

b) Supplementary equipment and supplies, and packaging.

c) Transportation costs:

1. Origin to CONUS port (consider three points of origin) by air or truck
2. CONUS to COMMZ by air or by sea plus air if necessary
3. Intratheater by air or truck.

d) Placement costs: men, equipment.

e) Maintenance costs: men, equipment. Assume sufficient maintenance supplies are included in initial shipment (if airfield life is less than anticipated membrane service life).

f) Residual value computed at COMMZ (equal to cost new at COMMZ of same amount of material recovered, less recovery cost, less retroshipment costs) will be credited to total airfield costs. Approximately 90 percent of the membrane will be recovered. Multiple recovery effects will be ignored.

g) Costs will be presented as initial, shipping, emplacement, recovery, retroshipment, residual, maintenance, and total cost, by airfield type, theater, and overall.

h) Maintenance and equipment requirements and shipping tonnages will be presented separately by airfield type, theater, and overall.

i) R&D costs will not be included, but will be considered as common sunk and/or product development costs.

j) Storage costs at depots are considered to be small and will not be included.

Initial Cost

87. Membrane cost per square foot was established for three neoprene-coated nylon fabrics, T-16, T-17, and WX-18 (see Appendix D), from an assortment of data representing various manufacturers and various quantities (from 100,000 to 6,000,000 square feet). Individual prices varied as much as 10 percent above and below the selected values. Using the wholesale consumer price index (Fig. 6), the following formula was derived for projecting the cost figures to 1975:

$$C_{75} = C_y \times [1.0 + 0.0081 \times (1975 - y)]$$

where C_{75} = cost in 1975
C_y = cost in year y
y = year for which cost was available.

Projected costs were plotted as a function of membrane weight in Figure 7, for which the following relationship appears to be appropriate:

$$CI = 2.0 \times WT \tag{81}$$

where CI = initial cost of membrane FOB factory, 1975 ($/sq ft)
WT = membrane weight (lb/sq ft).

88. The cost of accessories (adhesives, anchors, applicators, etc.) add approximately 10 percent to the initial cost. It is assumed that all membrane for traffic areas will be purchased with factory-applied antiskid compound, which adds about 10 cents per square foot to the initial cost. Thus the initial cost of membrane and accessories may be computed by

$$CI = 2.2 \times WT + .10. \tag{82}$$

Maintenance Supplies

89. Sufficient membrane maintenance supplies were included in the initial shipment to last for the anticipated life of a given field (Table 12) based on the anticipated service life (Table 12) of the membrane on that field. Equation 82 then becomes

$$C_{i}T = \left[2.2\ WT + 0.1\right]\left[1 + 0.1\ \frac{S_T}{S_L}\right] A \tag{83}$$

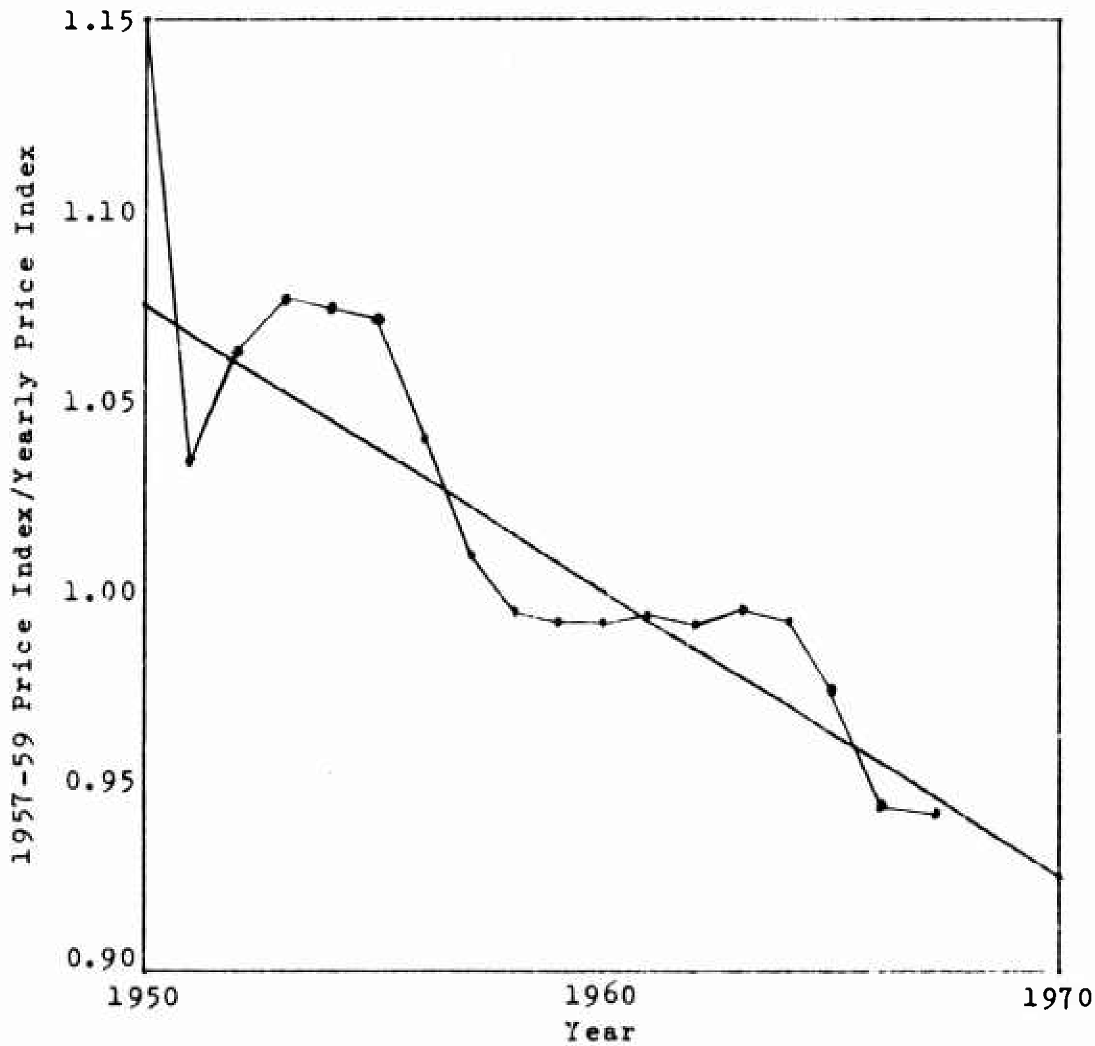

Figure 6. Purchasing power of the dollar (Wholesale Prices - Source: U. S. Department of Labor, Bureau of Labor Statistics).

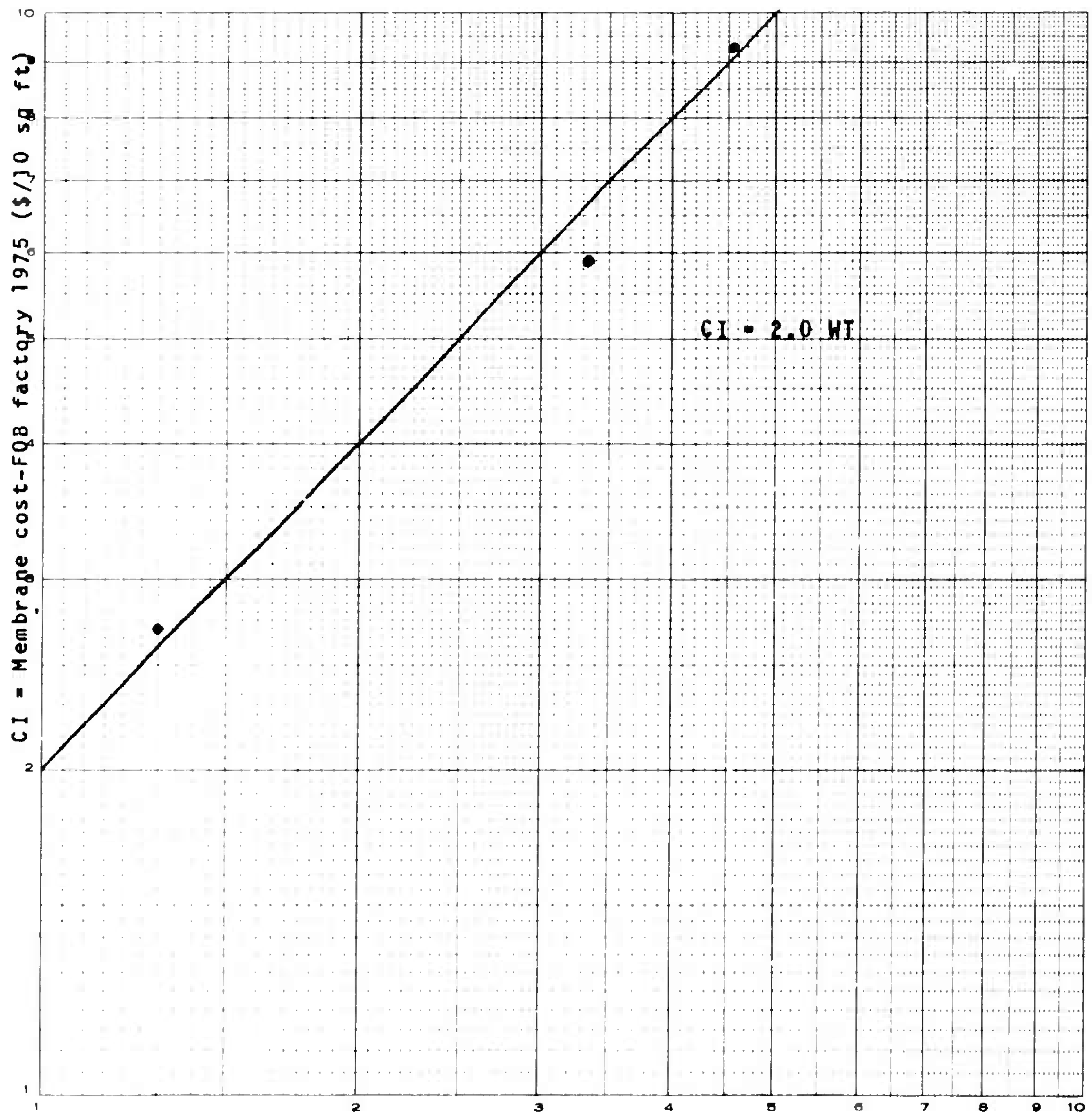

Fig. 7. Membrane cost as a function of weight (without antiskid).

where CIT = total initial cost of membrane, accessories, and maintenance supplies ($)
WT = membrane weight (lb/sq ft)
S_T = anticipated life of airfield (sorties)
S_L = anticipated service life (sorties)
A = membrane area (sq ft).

Transportation Costs

90. Standard planning rates for shipments by truck, sea, and air were provided by WES. These data were applied to each theater as shown in Table 13.

91. For air shipment from the factory to the field,

$$CSTA = (COPA \times DOPA + CCCA \times DCCA + CCFA \times DCFA) \times TON \quad (84)$$

where CSTA = total shipping cost by air
COPA = cost per ton-mile from origin to CONUS port
CCCA = cost per ton-mile from CONUS to COMMZ
CCFA = cost per ton-mile from COMMZ to field
DOPA = air distance from origin to CONUS port
DCCA = air distance from CONUS to COMMZ
DCFA = air distance from COMMZ to field
TON = total tonnage of membrane and accessories for a given airfield.

92. For surface shipment,

$$CSTS = (COPS \times DOPS + CCCS \times DCCS + CCCA \times DCCSA + CCFS \times DCFS) \times TON \quad (85)$$

where CSTS = total shipping cost by surface mode (truck and ship)
COPS = cost per ton-mile from origin to CONUS port
CCCS = cost per ton-mile from CONUS to COMMZ
CCCA = cost per ton-mile from CONUS to COMMZ by air when necessary
CCFS = cost per ton-mile from COMMZ to field
DOPS = truck distance from origin to CONUS port
DCCS = ship distance from CONUS to COMMZ port
DCCSA = air distance from COMMZ port to COMMZ when necessary
DCFS = truck distance from COMMZ to field
TON = defined above.

Table 13

Transportation Costs

	Transportation Cost by Theater ($/ton-mile)				
	1	2	3	4	5
CONUS - truck	0.047	0.047	0.047	0.047	0.047
CONUS - air	0.195	0.195	0.195	0.195	0.195
CONUS to COMMZ - ship	0.0049	0.0037	0.0037	0.0049	0.0042
CONUS to COMMZ - air	0.051	0.086	0.086	0.051	0.070
COMMZ to field - truck	0.047	0.047	0.047	0.047	0.047
COMMZ to field - air	0.195	0.195	0.195	0.195	0.195

Placement Cost

93. Manpower cost is obtained by multiplying placement man-hours by cost per man-hour. Placement man-hours are determined by dividing membrane area by placement rate (par. 57). For this computation, it was assumed that the placement crew would consist of military personnel in E4-E6 grades. The average planning cost per man-hour in these pay grades for an overseas theater of operations is about $3.20 (Ref. 13). (This figure apparently represents direct labor and excludes overhead such as food and quarters.)

94. Minimum equipment required for emplacing prefabricated membrane surfacing on an airfield includes a motor grader to open and close anchor ditches, and a 2-1/2 or 5 ton truck to transport membrane and supplies around the airfield (Ref. 7,8).* From current experience with membrane placement (Ref. 9,10), a relationship was established between equipment hours and membrane area (Fig. 8). The cost per equipment hour is estimated as $15.00.

95. Total placement cost may be expressed as the sum of manpower and equipment operating costs:

$$CP = 3.20 \times \frac{A \times WT^2}{50} + 15.00 \times \frac{1}{40} \times \left[\frac{A}{1000}\right]^{3/2}$$

or
$$CP = 0.064 \times A \times WT^2 + 0.375 \left[\frac{A}{1000}\right]^{3/2} \qquad (86)$$

where CP = total placement cost ($)
A = membrane area (sq ft)
WT = membrane weight (lb/sq ft).

Maintenance Cost

96. Maintenance man-hours per sortie are calculated as described in paragraph 56. Equipment hours per sortie are equal to maintenance man-hours per sortie divided by crew size. The cost per man-hour is $3.20 (Ref. 13)and the cost per equipment hour for inspection and repairs is estimated as $5.00. Thus, total maintenance cost per sortie is

---

*Depending on the type of construction unit and location, other types of equipment may be used. For example, the 8th Engineer Battalion of the 1st Cavalry Division in Vietnam used bulldozers, scrapers, loaders, and 1-ton dump trucks (Ref. 20).

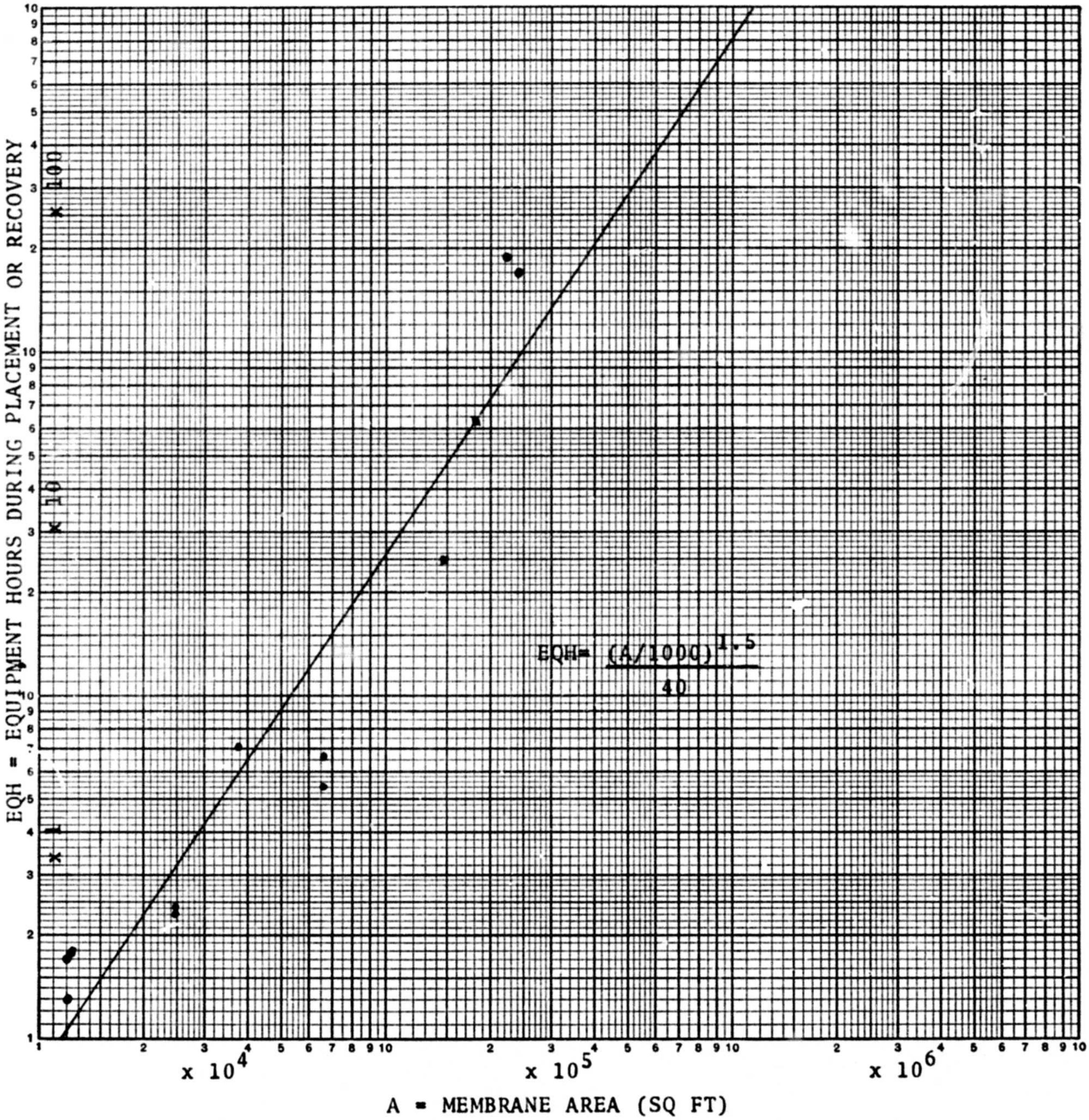

Figure 8. Equipment hours as a function of membrane area.

$$C_M = MMH \left[3.20 + \frac{5.00}{C \times N}\right] \qquad (87)$$

where C_M = maintenance cost per sortie for men and equipment
C = crew size
N = number of crews working simultaneously.

The cost of membrane maintenance supplies is included in the initial cost for each field.

Recovery Cost

97. Based on recovery rates achieved for T-17 (Ref. 2) and WX-18 (Ref. 3), recovery rate may be expressed as a function of membrane weight (Fig. 9). Equipment hours required for recovery are approximately equal to those required for placement. Approximately 90 percent of the emplaced membrane will be recovered in reusable condition, including the patched areas. Total recovery cost is given by the following equation:

$$C_R = 3.20 \times 0.9 \times \frac{A \times WT^{7/8}}{75} + 15.00 \times \frac{1}{40} \times \left[\frac{A}{1000}\right]^{3/2}$$

or

$$C_R = 0.0384 \times A \times WT^{7/8} + 0.375 \left[\frac{A}{1000}\right]^{3/2} \qquad (88)$$

where C_R = recovery cost ($)
A = membrane area (sq ft)
WT = membrane weight (lb/sq ft).

Recovered Value

98. The value of the membrane recovered and returned to COMMZ is equal to the cost of the same amount of new material at COMMZ less recovery and retroshipment costs. Thus, from equation 82, the initial value of the recovered membrane is

$$CIR = 0.9 \times A \times (2.2 \times WT + 0.1). \qquad (89)$$

Shipping costs from origin to COMMZ by air (from eq. 84) are:

$$CSACR = (COPA \times DOPA + CCCA \times DCCA) \times TON \times 0.9, \qquad (90)$$

and by surface mode (from eq. 85):

$$CSSCR = (COPS \times DOPS + CCCS \times DCCS + CCCA \times DCCSA) \times TON \times 0.9. \qquad (91)$$

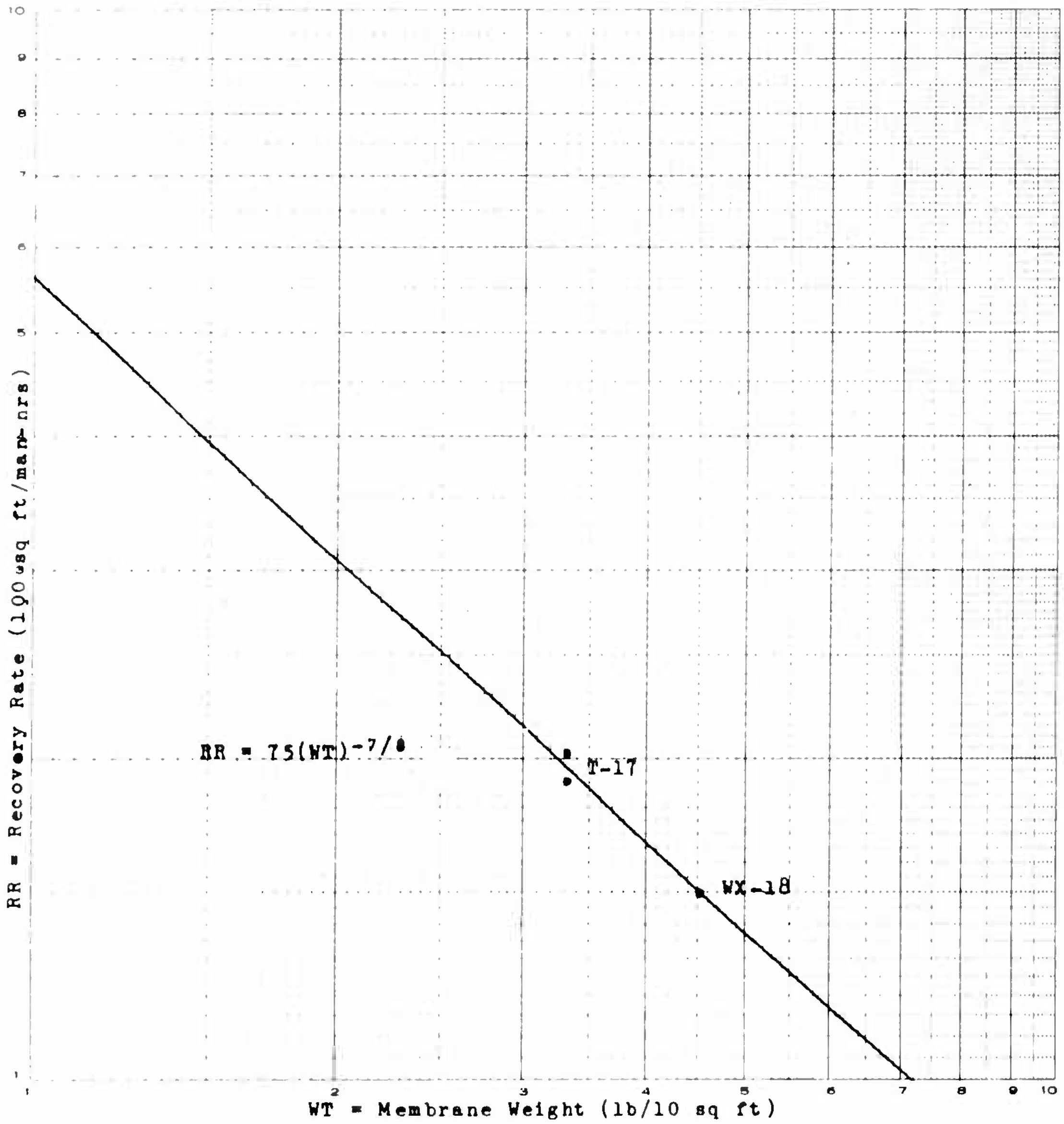

Figure 9. Recovery rate as a function of membrane weight

The cost of retroshipment from the field back to COMMZ by air (from eq. 84) is:

$$CSAB = CCFA \times DCFA \times TON \times 0.9; \tag{92}$$

and by truck (from eq. 85),

$$CSSB = CCFS \times DCFS \times TON \times 0.9. \tag{93}$$

The net recovered value by air (from eq. 88,89,90,92) is

$$RVA = CIR + CSACR - CR - CSAB, \tag{94}$$

and by surface mode,

$$RVS = CIR + CSSCR - CR - CSSB. \tag{95}$$

Total Fixed Cost

99. From equations 83, 84, 85, 86, 94, and 95, the total fixed cost per airfield may be calculated as follows:

$$CFA = CIT + CSTA + CP - RVA \quad \text{by air} \tag{96}$$

$$CFS = CIT + CSTS + CP - RVS \quad \text{by surface.} \tag{97}$$

Total Membrane-Related Cost Per Field

100. By multiplying equation 87 by the number of sorties expected during the life of the field to obtain the total maintenance cost, and adding this to equations 96 and 97, the total cost of a membrane-covered field is:

$$CTA = CFA + CM \times ST \quad \text{by air} \tag{98}$$

$$CTS = CFS + CM \times ST \quad \text{by surface.} \tag{99}$$

A Caveat

101. Since the purpose of the study is to provide a basis for deciding whether to develop a family of membranes or a single membrane, it appears that relative costs of various systems are more important than absolute costs. Accordingly, no attempt has been made to develop a highly accurate cost model. However, all significant costs have been considered and treated systematically so that relative costs should be reliable.

COST EFFECTIVENESS

102. The total cost of a membrane system on a given airfield is, by itself, a measure of effectiveness, since the system has been designed for the minimum acceptable level of effectiveness, based on the QMR. The system which gives an effectiveness of 1.0 for the least cost should be the most desirable. However, in cases where several different systems have equal or nearly equal costs, a discriminator is needed.

103. A cost effectiveness ratio may be obtained by dividing total cost (par. 100) by the effectiveness (par. 76). This will produce a total cost, adjusted for effectiveness greater or less than 1.0, for a given membrane system on a given airfield.

104. For each theater an average cost effectiveness may be computed by weighting the cost effectiveness of each airfield according to the number of fields of that type in the theater. An overall average for all theaters may be obtained in the same manner.

COMPUTER PROGRAMS

105. Computer programs developed during this study are included in Appendix B. All programs are written in FORTRAN IV language and have been compiled and executed on an IBM 1130 computer with 8K core and 500K disk storage. It should be noted that these programs were written for the specific job at hand and, while they can be modified or extended to explore different aspects of the same problem, they are not designed as general purpose programs for either cost effectiveness studies or airfield surfacing studies.

106. Minimum membrane strength and area requirements were determined by program JB183 and subroutines AFDAT and CAL1, as follows:

a) JB183 is the main program which reads input data from cards, and calls subroutines as necessary.

b) The AFDAT subroutine adjusts sea-level airfield dimensions for the elevation and temperature of a given theater and computes membrane areas required to surface those portions of the airfield subjected to traffic, i.e., runway ends, runway centers, and taxi-park. Also, the distances traveled during membrane inspection are computed.

c) Subroutine CAL1 computes the minimum membrane strengths required to satisfy QMR availability, maintenance effort, and service life, using a one-, two-, or three-membrane system. Inspection frequencies and the probability of no damage between inspections are determined. Membrane strengths, weights, and performance data are printed and stored.

107. Membrane duty classes are defined by the program called CLASS, as outlined in paragraph 39.

108. Membrane effectiveness, cost, and cost effectiveness are computed by program MAIN1 and subroutines ISSUE, NSPEC, EFFECT, and COST, as follows:

a) The MAIN1 program reads input data from cards, calls subroutines, and prints results.

b) Subroutine ISSUE determines how a given membrane system will be applied to a particular airfield by comparing available duty classes with required duty classes. QMR placement rates for the system are also identified in this program.

c) Subroutine NSPEC computes MSBD's and determines inspection frequency.

d) Subroutine EFFECT computes downtime, availability, maintenance man-hours, weight, placement rate, recovery rate, service life, and effectiveness.

e) Subroutine COST computes initial membrane cost, shipping cost by air and surface modes, placement cost, recovery cost, retroshipping cost, value of recovered membrane, maintenance cost, total cost, and cost effectiveness.

III. MEMBRANE DUTY CLASSES

MINIMUM STRENGTH REQUIREMENTS

109. Following the procedure described in Chapter II, paragraph 38, and utilizing the relationships established for availability and downtime (eq. 28), maintenance man-hours (eq. 46), and service life (eq. 62,63,64), minimum membrane strength requirements were determined for one-, two-, and three-membrane systems for each airfield in each theater. The minimum strength was selected as the largest of the three values obtained from availability, maintenance, and service life considerations. The selected minimum strengths were then used to calculate the final values for availability, maintenance man-hours, service life, membrane weight, MSBD, and inspection frequency. The results are presented in Table 14.

DUTY CLASSES

110. Membrane tensile strengths from Table 14 were arranged in order from smallest to largest and grouped in numbered classes as discussed in Chapter II, paragraph 39. For each class

$$NS_{min} = 0.9\ NS_{max},$$

and the characteristic strength for the class is taken as NS_{max}. For SAML airfields in theaters 3 and 5, it was found that by using a two-membrane system, the maximum membrane strength requirement could be reduced to 3064 pounds per inch. This effectively reduces the number of membrane strengths to be examined to 21 numbered classes as shown in Table 15, and results in an overall weight saving for all membrane systems at all airfields in all theaters, except for the three-membrane system at the two fields in the two theaters just mentioned.

111. By comparing the minimum required strengths from Table 14 with the duty classes in Table 15, membrane requirements may be expressed in terms of numbered duty classes. These are given in Table 16, along with the corresponding weight of membrane and accessories to the nearest ton. In all cases except for SAML airfields in theaters 3 and 5, the membrane system which gave minimum tonnage per field was selected.

SUBOPTIMIZED MEMBRANE SYSTEMS

112. As described in Chapter II, paragraph 41, duty class 21 was examined alone and with all possible combinations of classes 1 to 20 to obtain a two- and three-membrane system with minimum weight. The optimum combinations of membranes are listed in Table 17, along with the total tonnage required to surface all airfields in all theaters.

113. The actual deployment and tonnage of each of the three suboptimized membrane systems for each airfield in each theater are presented in Tables 18a, 18b, and 18c. Deployment was determined by comparing the required duty classes from Table 16 with the duty classes available in the sytem. In each case, the duty class selected was equal to or greater than the duty class required.

114. From Table 17 and Tables 18a, 18b, and 18c, the advantage of two- and three-membrane systems over a single-weight system is readily apparent. Total tonnage may be reduced by a factor of 3 by going to a two-membrane, and a small additional improvement is realized by going to a three-membrane system. These three systems and others will be examined in more detail under Phase II, Chapter V.

MEMBRANES ON MILITARY ROADS AROUND AIRFIELDS

115. Laboratory and field experience indicates that prefabricated membranes may be used as expedient surfacing on pioneer roads (Ref. 15,16). T-12 membrane has withstood 615 passes of an M48 tank (Ref. 15) and T-17 membrane has withstood 2000 passes of mixed, wheeled traffic (M151, M37, and M35) at speeds up to 30 mph (Ref. 16), all without damage. There are insufficient data, however, to develop a reliable model of mean passes between damage as a function of applied loads from ground vehicle traffic (tracked and wheeled) and of membrane strength.

116. Since the lightest material appearing in the optimum membrane systems is class 7 (equivalent to T-12) and the heaviest is class 21 (stronger than T-17), it is evident that a membrane class will be available which is suitable for military roads.

Table 14

Minimum Membrane Strength Requirements and Performance

Theater	Airfield[1]	Membrane System	Tensile Strength (*lb/in*) Runway End	Tensile Strength (*lb/in*) Runway Center	Tensile Strength (*lb/in*) Taxipark	Membrane Weight (*tons*) Runway End	Membrane Weight (*tons*) Runway Center	Membrane Weight (*tons*) Taxipark	Membrane Weight (*tons*) Total
1	FAML	1	690	690	690	6	12	26	44
		2	786	786	690	7	14	26	47
		3	1005	690	690	9	12	26	47
	SAML	1	1752	1752	1752	23	46	174	243
		2	1752	1752	1752	23	46	174	243
		3	1752	1752	1752	23	46	174	243
2	FAML	1	701	701	701	6	13	26	45
		2	781	781	701	7	15	26	48
		3	998	701	701	9	13	26	48
	SAML	1	2035	2035	2035	27	54	204	285
		2	2035	2035	466	27	54	46	127
		3	2465	1232	466	33	33	46	112
3	FAML	1	699	699	699	6	13	27	46
		2	775	775	482	7	15	18	40
		3	991	495	482	9	9	18	36
	SAML	1	3064	3064	3064	42	85	309	436
		2	3064	3064	457	42	85	46	173
		3	3712	1856	457	51	51	46	148
4	FAML	1	839	839	839	10	21	36	67
		2	839	839	839	10	21	36	67
		3	928	839	839	12	21	36	69
	SAML	1	1901	1901	1901	34	68	206	308
		2	1901	1901	571	34	68	61	163
		3	2303	1151	571	41	41	61	143
5	FAML	1	1344	1344	1344	25	51	70	146
		2	1344	1344	369	25	51	19	95
		3	1628	814	369	31	31	19	81
	SAML	1	2570	2570	2570	69	138	319	526
		2	2570	2570	523	69	138	65	272
		3	3113	1556	523	83	83	65	231
1-5	FAH	1	0	0	623	0	0	41	4[illegible]

[1] BAML fields are not included because they are short-life fields and are assumed to be left bare. RAHL and RAT fields are not included because they are long-life fields and are assumed to be mat-covered.

Table 14 (cont'd.)

Mean Sorties Between Tears			Avail.	Down-time	Man-hours	Inspection		Service Life		
Runway *End*	*Runway* *Center*	*Taxi-park*				*Sorties*	*Prob.*[2]	*Runway* *End*	*Runway* *Center*	*Taxi-park*
2	23	184	93.0	.239	.749	1	.67	1647	1647	1647
4	34	184	94.3	.193	.674	1	.76	1199	1199	69065
8	23	184	95.5	.154	.609	1	.85	1199	4269	69065
16	133	1071	95.3	.160	.750	1	.93	36016	36016	36016
16	133	1071	95.3	.160	.750	1	.93	10359	10359	1883319
16	133	1071	95.3	.160	.750	1	.93	3884	62158	1883319
3	24	194	93.1	.235	.749	1	.69	1788	1788	1788
4	33	194	94.2	.197	.688	1	.76	1199	1199	74456
8	24	194	95.4	.156	.620	1	.85	1199	4677	74456
26	209	1676	97.5	.085	.720	2	.91	66245	66245	66245
26	209	20	97.5	.085	.750	2	.91	19321	19321	9541
46	46	20	97.5	.085	.750	2	.91	15604	15604	9541
3	24	192	93.0	.240	.743	1	.68	1799	1799	1799
4	32	63	94.0	.203	.689	1	.75	1199	1199	16826
8	8	63	94.5	.188	.665	1	.79	1199	1199	16826
89	715	5722	99.2	.025	.492	7	.91	345297	345297	345297
89	715	18	99.2	.025	.523	7	.91	102407	102407	8823
158	158	18	99.2	.025	.523	7	.91	62705	82705	8823
5	41	332	93.7	.212	.749	1	.80	4475	4475	4475
5	41	332	93.7	.212	.749	1	.80	2144	2144	172344
7	41	332	94.3	.194	.720	1	.84	1199	12865	172344
21	170	1366	96.7	.112	.734	2	.90	58355	58355	58355
21	170	37	96.7	.112	.750	2	.90	19729	19729	23118
37	37	37	96.7	.112	.750	2	.90	15933	15933	23118
21	170	1366	96.5	.118	.673	2	.90	39559	39559	39559
21	170	28	96.5	.118	.693	2	.90	20948	20948	7908
37	37	28	96.5	.118	.693	2	.90	16918	16918	7908
52	422	3377	97.7	.077	.693	4	.91	245606	245606	245606
52	422	28	97.7	.077	.714	4	.91	97997	97997	18654
93	93	28	97.7	.077	.714	4	.91	79143	79143	18654
0	0	2	93.5	.222	.438	1	.61	0	0	1200

[2] Probability of no damage between inspections.

Table 15

Definition of Membrane Duty Classes

Duty Class	Tensile Strength	Membrane Weight
	(lb/in)	*(lb/sq ft)*
1	372	0.110
2	413	0.122
3	459 (T16)	0.136
4	511	0.151
5	567	0.167
6	630	0.186
7	700 (T12)	0.207
8	778	0.230
9	865	0.256
10	961 (T17)	0.284
11	1068	0.316
12	1187	0.351
13	1319	0.390
14	1465	0.433
15	1628	0.481
16	1809	0.535
17	2010 (WX-18)	0.594
18	2233	0.660
19	2482	0.734
20	2757	0.815
21	3064	0.906

Table 16

Membrane Requirements in Terms of Duty Classes

Theater	Airfield	Duty Class Required			Weight of Membranes & Accessories (tons)		
		Runway		*Taxi-Park*	*Runway*		*Taxi-Park*
		Ends	*Center*		*Ends*	*Center*	
1	FAML	7	7	7	9	19	39
	SAML	16	16	16	35	71	270
	FAH	0	0	7	0	0	69
2	FAML	8	8	8	11	22	44
	SAML	19	13	4	50	53	76
	FAH	0	0	7	0	0	69
3	FAML	11	4	4	15	15	29
	SAML	21	21	3	64	128	69
	FAH	0	0	7	0	0	69
4	FAML	9	9	9	16	33	56
	SAML	19	12	6	67	64	102
	FAH	0	0	7	0	0	69
5	FAML	16	9	1	52	49	29
	SAML	20	20	5	111	222	105
	FAH	0	0	7	0	0	69

Table 17

Suboptimized Membrane Systems

No. of membranes in system	Duty Classes			Total wt. of membrane & accessories (tons)
	Heavy	*Medium*	*Light*	
1	21	-	-	65,767
2	21	-	7	20,724
3	21	9	7	17,927

Table 18a

One-Membrane System - Class 21

Theater	Air-field	Duty Classes			Wt. of Membrane & Access. per Field	No. Fields in Theater	Total Weight
		Runway		*Taxi-park*	*(tons)*		*(tons)*
		Ends	*Center*				
1	FAML	21	21	21	304	12	3,648
	SAML	21	21	21	639	3	1,917
	FAH	-	-	21	302	47	14,194
							19,759
2	FAML	21	21	21	309	6	1,854
	SAML	21	21	21	646	2	1,292
	FAH	-	-	21	302	39	11,778
							14,924
3	FAML	21	21	21	315	3	945
	SAML	21	21	21	656	1	656
	FAH	-	-	21	302	13	3,926
							[illegible],527
4	FAML	21	21	21	377	4	1,508
	SAML	21	21	21	748	1	748
	FAH	-	-	21	302	56	16,912
							19,168
5	FAML	21	21	21	507	3	1,521
	SAML	21	21	21	942	1	942
	FAH	-	-	21	302	13	3,926
							6,389
						OVERALL TOTAL	*65,767*

Table 18b

Two-Membrane System - Classes 21 and 7

Theater	Air-field	Duty Classes: Runway Ends	Duty Classes: Runway Center	Duty Classes: Taxi-park	Wt. of Membrane & Access. per Field (tons)	No. Fields in Theater	Total Weight (tons)
1	FAML	7	7	7	69	12	828
	SAML	21	21	21	639	3	1,917
	FAH	-	-	7	69	47	3,243
							5,988
2	FAML	21	21	21	309	6	1,854
	SAML	21	21	7	291	2	582
	FAH	-	-	7	69	39	2,691
							5,127
3	FAML	21	7	7	107	3	321
	SAML	21	21	7	298	1	298
	FAH	-	-	7	69	13	897
							1,516
4	FAML	21	21	21	377	4	1,508
	SAML	21	21	7	363	1	363
	FAH	-	-	7	69	56	3,864
							5,735
5	FAML	21	21	7	320	3	960
	SAML	21	21	7	501	1	501
	FAH	-	-	7	69	13	897
							2,358
						OVERALL TOTAL	*20,724*

Table 18c

Three-Membrane System - Classes 21, 9, and 7

Theater	Airfield	Duty Classes			Wt. of Membrane & Access. per Field	No. Fields in Theater	Total Weight
		Runway		*Taxi-*	*(tons)*		*(tons)*
		Ends	*Center*	*park*			
1	FAML	7	7	7	69	12	828
	SAML	21	21	21	639	3	1,917
	FAH	-	-	7	69	47	3,243
							5,988
2	FAML	9	9	9	87	6	522
	SAML	21	21	7	291	2	582
	FAH	-	-	7	69	39	2,691
							3,795
3	FAML	21	7	7	107	3	321
	SAML	21	21	7	298	1	298
	FAH	-	-	7	69	13	897
							1,516
4	FAML	9	9	9	106	4	424
	SAML	21	21	7	363	1	363
	FAH	-	-	7	69	56	3,864
							4,651
5	FAML	21	9	7	193	3	579
	SAML	21	21	7	501	1	501
	FAH	-	-	7	69	13	897
							1,977
						OVERALL TOTAL	*17,927*

MEMBRANES UNDER LANDING MAT AND ON NON-TRAFFIC AREAS

117. Membranes used for waterproofing and dustproofing subgrades under landing mat are not in direct contact with applied wheel loads. Therefore, the model developed for mean sorties between damage (Fig. 1) is clearly not applicable. Laboratory tests have shown that T-16 and laminated vinyl-coated nylon (Ref. 17) are suitable for use under AM1 landing mat, which is relatively smooth on the underside. For landing mat with a more aggressive undersurface (e.g., M8), it is doubtful that membranes of lower strength than T-16 will be effective. It is evident, however, that membranes for use under landing mat may be lower in strength than any of those proposed in the optimum systems for traffic areas (Chap. V). Until such time that laboratory and field tests indicate otherwise, T-16 should be considered as adequate for use under all landing mat. For mat with smooth, flat undersides (such as AM2, MX18, MX19), lighter and cheaper materials, such as laminated vinyl-coated nylon or comparable material, may be used.

118. Areas along the periphery and inner boundaries of airfield traffic areas which require water/dustproofing are, for planning purposes, approximately equal to the traffic area itself. (For sample layout of dustproofing area around a medium lift airfield, see Ref. 2). Because of this large demand for membrane on non-traffic areas, it is essential that such membrane be as lightweight and as inexpensive as possible. If these areas are truly non-traffic areas (i.e., restricted from air and ground traffic), then the membrane is only required to withstand the elements (e.g., wind, hail), propeller blasts during engine runups, downwash from helicopters, and possibly traffic by men on foot and animals. For this usage, laminated vinyl-coated nylon membranes are probably sufficient. If occasional, light, ground vehicle traffic or aircraft overruns are to be expected, T-16 would be more suitable. However, the higher cost of T-16 (approximately three times greater than laminated vinyl-coated nylon) must be compared with the cost of maintaining lighter materials. It will be shown later in this study that maintenance costs are almost negligible compared with the cost of purchasing, shipping, and emplacing membranes.

EXTRA-LIGHT DUTY MEMBRANE

119. Initially, the membrane to be used on non-traffic areas and under landing mats was to be the lightest membrane recommended for use on traffic areas as a result of this study. As the study progressed, however, it became apparent

that such a policy would result in unwarranted and unnecessary increases in system cost. As indicated in the preceding section, membranes suitable for use on non-traffic areas and under mats are much lower in strength and weight than the lightest membrane suitable for use on airfield traffic areas. It is recalled from Chapter II that initial cost, shipping cost, placement cost, and recovery cost are all directly related to membrane weight. Furthermore, the non-traffic areas to be waterproofed and dustproofed are approximately equal in size to the traffic areas.

120. In view of the large requirement for membrane under landing mat and on non-traffic areas, and considering the light loads involved, it is evident that a separate membrane duty class is required (apart from those for traffic areas). While additional study is required to determine the optimum characteristics of such a membrane, it appears that vinyl or neoprene-coated nylon fabrics, with strength less than or equal to that of T-16, would be adequate. This duty class will be referred to as extra-light duty.

IV. TRADE-OFF ANALYSIS (PHASE I)

THE QMR PARAMETERS

121. The purpose of the analysis and parameters to be considered were given in Chapter I, paragraph 9. Those parameters which have been assigned specific values in the QMR are:

a)	Availability	- 93 percent with 15 percent replacement parts	
b)	Service life	- 1200 sorties with 10 percent replacement parts due to failures	
c)	Maintainability	- 0.75 man-hours per sortie	
d)	Reliability and durability	- 100 sorties between failures	
e)	Placement rate (essential)	- light	400 sq ft/mhr
		- medium	300 sq ft/mhr
		- heavy	200 sq ft/mhr
f)	Weight (essential)	- light	2.0 lb/sq yd
		- medium	4.0 lb/sq yd
		- heavy	6.0 lb/sq yd.

122. The remaining items, performance, transportability, producibility, and logistical support, are qualitative and cannot be readily analyzed. However, "performance' is implicit in items (a) to (f) above. "Transportability" and "logistical support" are closely related to the weight of membranes (item f) and accessories. "Producibility" is mainly a function of the materials involved and should be constant for this study since sufficient data were available for only neoprene-coated nylon fabrics. From past procurement records, it is evident that this material is readily producible in several weights, plies, and strengths.

123. To meet the QMR specification for reliability and durability, the membrane must be capable of withstanding 100 sorties between failures. No failure, as defined in the QMR (see par. 16, Chap. I), has ever been reported during field testing or operations. Thus, there is no basis for establishing a rate of occurrence model for tears of such magnitude. It must be assumed that membranes, which otherwise satisfy the QMR, will meet this requirement also.

124. Placement rate and weight are considered as dependent variables, i.e., membrane systems are selected which meet the QMR with minimum weight. Placement rate is then

determined from the relationship shown in Figure 4. Although this relationship is a trade-off between placement rate and weight, no trade-off is in fact possible because required strength determines weight and weight determines placement rate (for a given membrane material).

125. The remaining parameters listed in paragraph 121 are availability, maintainability, and service life. By varying each of these separately above and below its QMR value, the effect on the other parameters listed (except reliability-durability) and on total system weight and cost may be determined. Since the results were similar for all airfields in all theaters, results are shown for forward area medium lift (C-130) airfields in Theater 3 only.

AVAILABILITY

126. Target values of 88 to 98 percent were assigned to availability, while QMR values were used for service life and maintainability. The influence of these target values on values actually attained by a one-, two-, or three-membrane system is shown in Figure 10. It is evident that no advantage is obtained from lowering the QMR availability below about 92 percent since service life has "bottomed out" at its QMR value and maintenance man-hours and availability (attained) have leveled off, resulting in no additional savings in weight or cost.

127. Raising the QMR value to 95 percent or above results in increased weight and cost, maintenance man-hours have "topped out" at the QMR value, and placement rates are at or near the QMR minimums. It is apparent that if availability greater than the 95 percent is required, considerable savings in cost and weight are obtained from a two- or three-membrane system. Below 93 percent cost and weight are about equal for all three systems, but the multimembrane systems offer advantages of higher availability and lower maintenance.

128. The QMR availability of 93 percent is a practical minimum requirement.

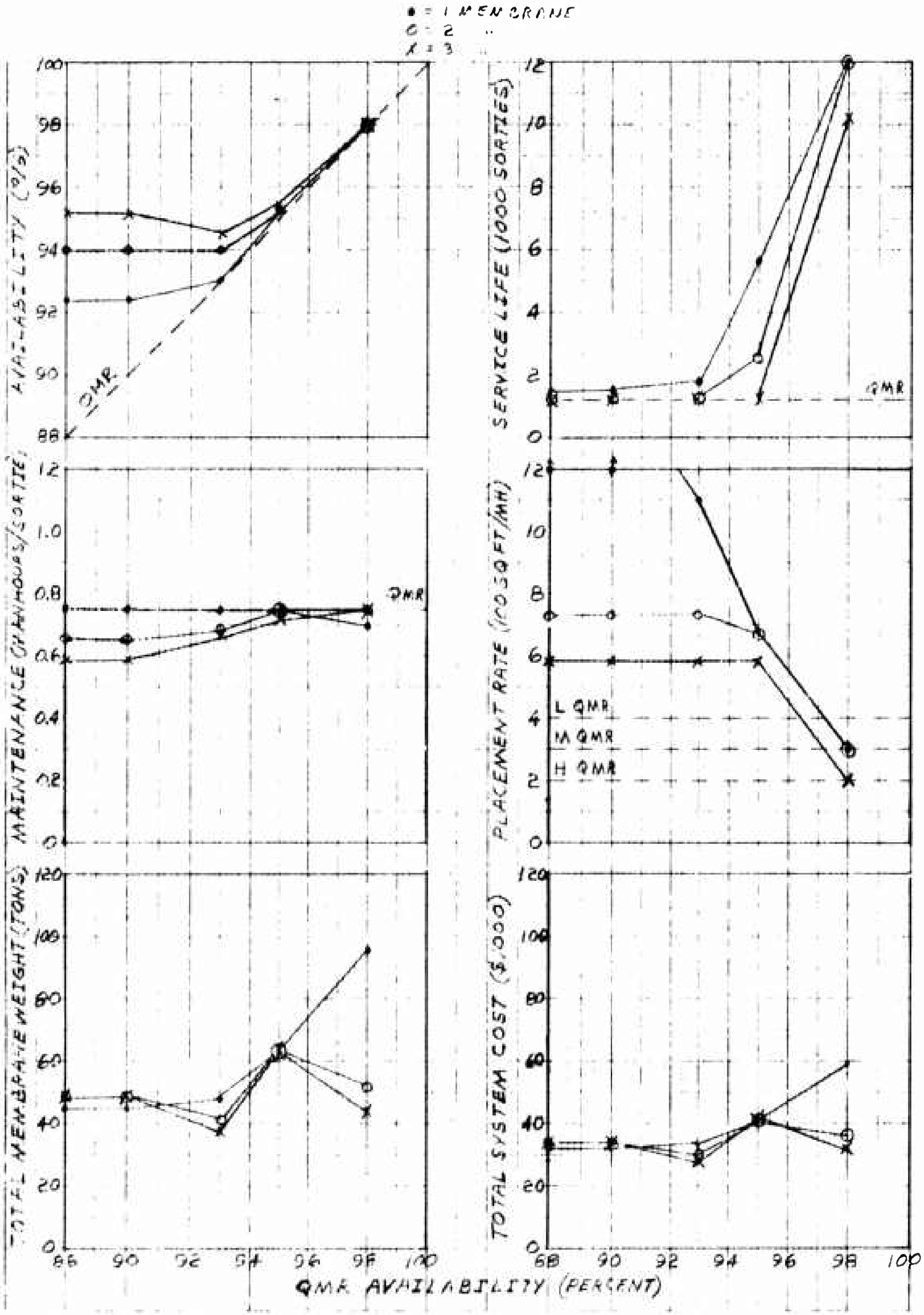

Figure 10. Influence of QMR availability requirement on performance, weight and cost.

MAINTAINABILITY

129. The maintenance requirement was varied from 0.5 to 1.1 man-hours per sortie, as shown in Figure 11. Minimum weight and cost are obtained in the range 0.75 to 0.90. By setting the QMR value at 0.90 instead of 0.75 man-hours per sortie, overall system cost and weight will be reduced by about 7 percent. A relaxation of this requirement is easily justified since it will be shown later that maintenance costs are insignificant when compared to overall system costs.

SERVICE LIFE

130. The service life requirement was varied from 600 to 1800 sorties, as indicated in Figure 12. Availability and maintenance level off at their respective QMR values when service life is reduced to 600 sorties. Considering the anticipated service life of forward and support area medium lift airfields (98 and 420 sorties, respectively), a service life of about 600 to 650 would not appear to be unreasonable. This means that replacement parts would be nearly expended by the end of the airfield service life. Additional replacement parts could then be issued when the membrane is recovered and moved to another field or depot. However, a reduction in membrane service life would not be desirable because of the long anticipated service life of forward area heliports (5400 sorties). Also, the savings in total system cost resulting from a change in QMR service life would be insignificant.

131. The QMR specifies that service life must be achieved with not more than 10 percent replacement parts. The effect of varying the replacement parts requirement from 5 to 15 percent is shown in Figure 13. For one-membrane systems, the requirement appears to be in order considering availability, maintenance, weight, and cost. For two- and three-membrane systems, the requirement could be relaxed to 15 percent and still be in balance with availability and maintenance, but no appreciable savings in system weight or cost would result.

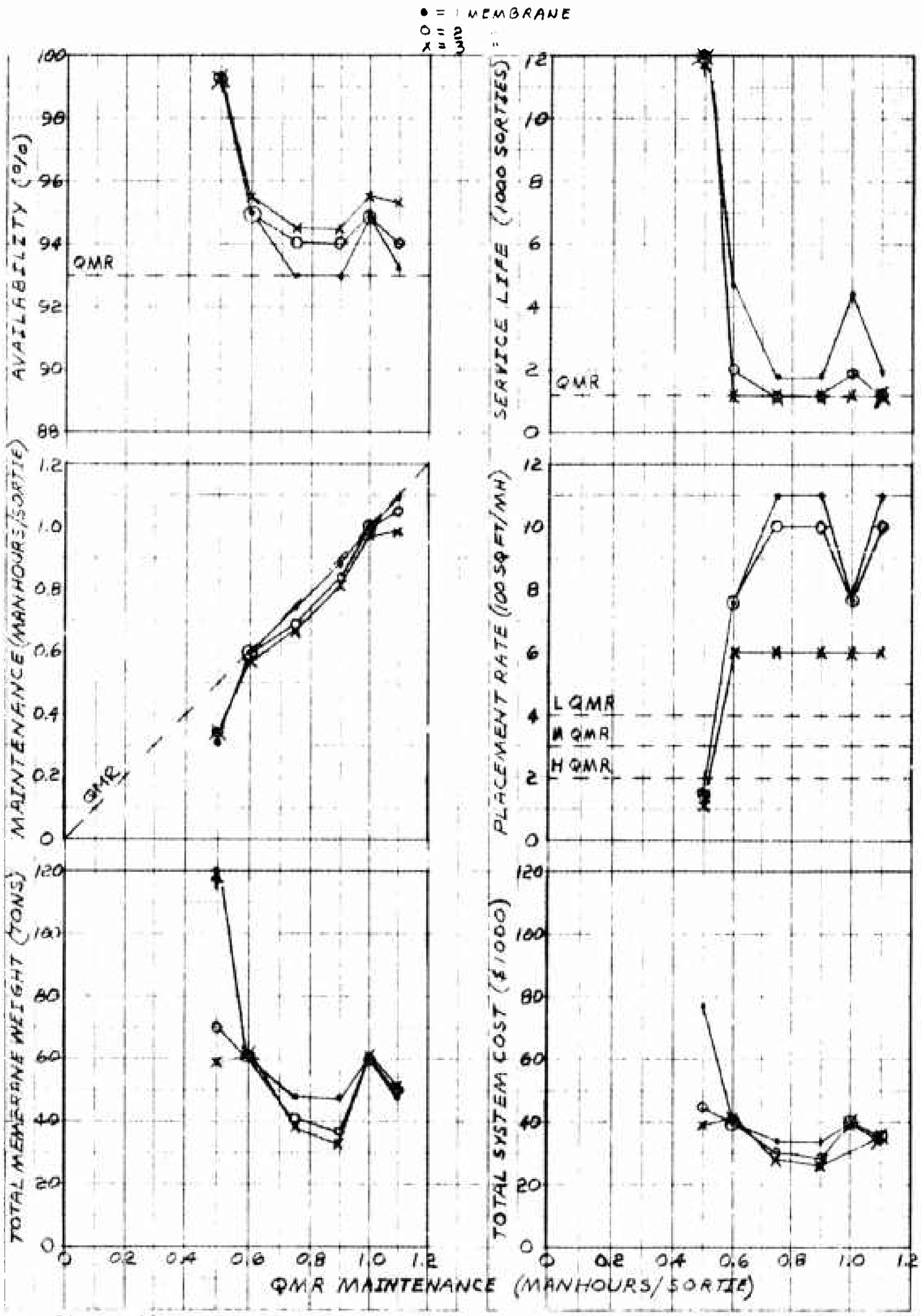

Figure 11. Influence of QMR maintenance requirement on performance, weight and cost.

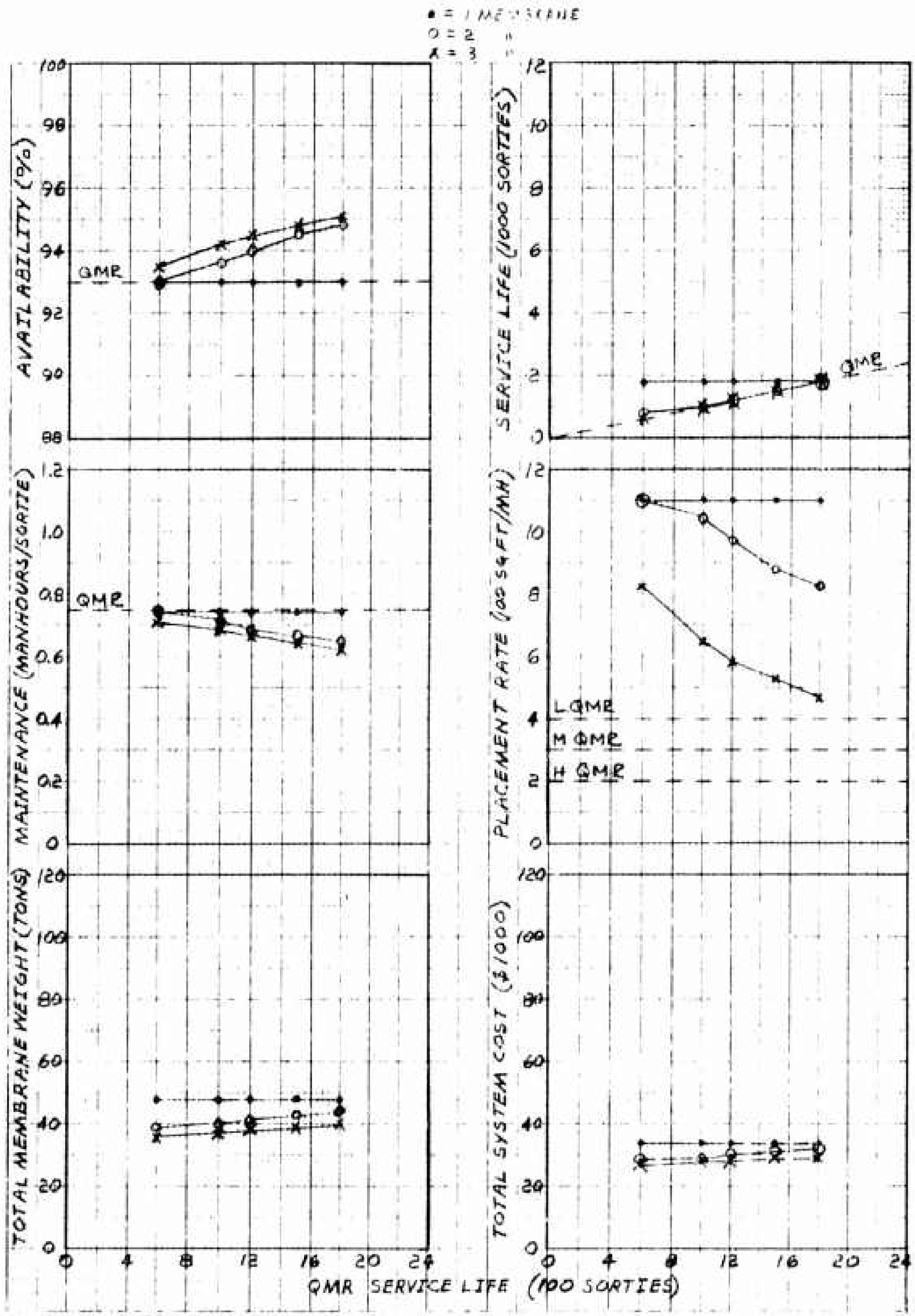

Figure 12. Influence of QMR service life requirement on performance, weight and cost.

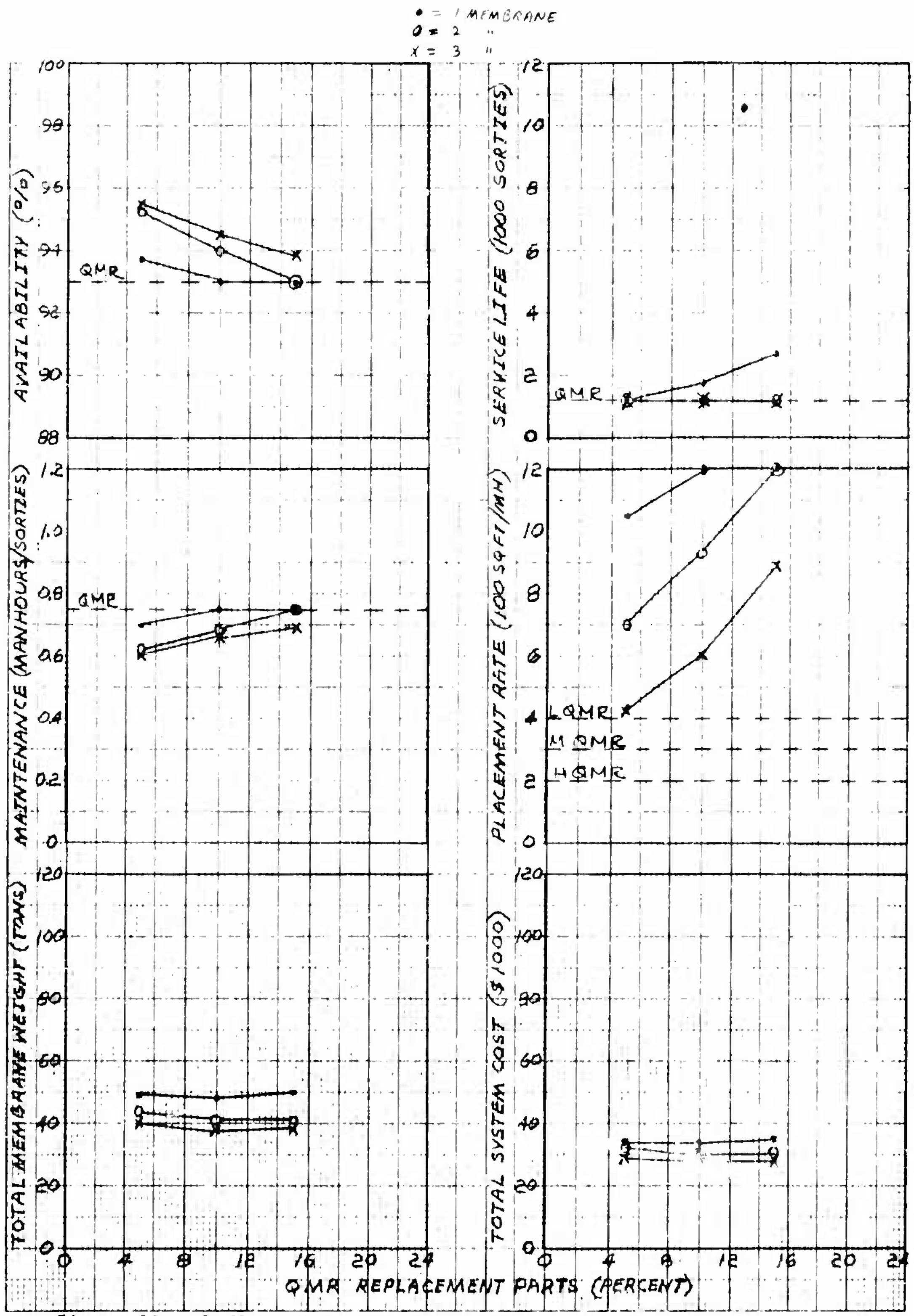

Figure 13. Influence of QMR replacement parts requirement on performance, weight and cost.

V. COST EFFECTIVENESS (PHASE II)

SENSITIVITY

132. In the models developed in Chapter II, the parameters which are not fixed by the choice of a specific theater and airfield or by the QMR are:

a) Point of origin
b) Shipping distance (air or surface)
c) Shipping cost (air or surface)
d) Inspection frequency for runway
e) Inspection frequency for taxi-park areas
f) Inspection vehicle velocity (during inspection)
g) Inspection vehicle velocity (to and from runway)
h) Maintenance crew size
i) Number of maintenance crews
j) Placement crew size
k) Number of placement crews
l) Adhesive drying time
m) Man-hours per repair
n) Effectiveness weighing factors.

Point of Origin

133. Three different points of origin were considered corresponding to factories of three potential manufacturers. The difference in overall system cost between the most expensive and least expensive origin (due to shipping cost) was about 7 percent. For alternate membrane systems originating from the same point, however, relative costs of the systems are not influenced by this parameter. After the influence of the point of origin had been established, this parameter was set at origin number 1 on all subsequent tests.

Shipping Distances and Costs

134. Shipping distances by truck in CONUS are 20 percent larger than corresponding air distances. In the theater of operations, truck distances were arbitrarily set 25 percent larger than air distances. Cost per ton-mile by air is roughly four times greater than by truck.

135. Shipping distances by sea (converted to statute miles) are approximately 12-1/2 percent larger than corresponding air distances. Cost per ton-mile is an average of 16 times greater by air than by sea.

136. Cost effectiveness data (Appendix C) were tabulated for two different modes of transportation: a) all air, and 2) all surface except air when necessary. Although cost differences due to mode of shipping have a large influence on the magnitude of overall system cost, relative costs between various membrane systems are unaffected.

Inspection Frequency

137. The QMR indicates that one inspection of the membrane per day is sufficient. However, allowing damage to the membrane to go unrepaired during inclement weather or risking the possibility of small tears developing into failures, would appear to defeat the purpose of the membrane. Accordingly, an inspection policy was adopted for this study based on a 90 percent probability of no damage between inspections, as discussed in Chapter II, paragraph 49.

138. As a result of this policy, runway inspections were usually required after each sortie while taxiway and parking area inspections were held after each two to four sorties. If inspections were required after each sortie, the 90 percent probability of no damage criterion was no longer necessary and was waived. Under these circumstances, it was found that the QMR could be satisfied on all counts with a probability of no damage as low as 60 to 70 percent.

139. On most support area airfields, the large membrane-covered areas required such large inspection times that the QMR maintenance requirement could not be met unless inspections were held only once or twice per day. This, in turn, meant that the 90 percent probability of no damage requirement had to be met. As a result of the self-imposed inspection policy, membrane strengths were forced higher than required by the QMR.

140. The inspection policy used in this study has a significant effect on membrane strength and, therefore, overall weight and cost of proposed membrane systems. While it appears to be an entirely reasonable and desirable policy, it should be considered when selecting an optimum membrane system.

Inspection Vehicle Velocity

141. The speed at which the inspection vehicle travels to and from the runway is not a critical parameter, but modest savings in system cost and weight result from higher speeds, as shown in Figure 14. For final cost-effectiveness computations, the speed to and from the runway was set at 20 miles per hour.

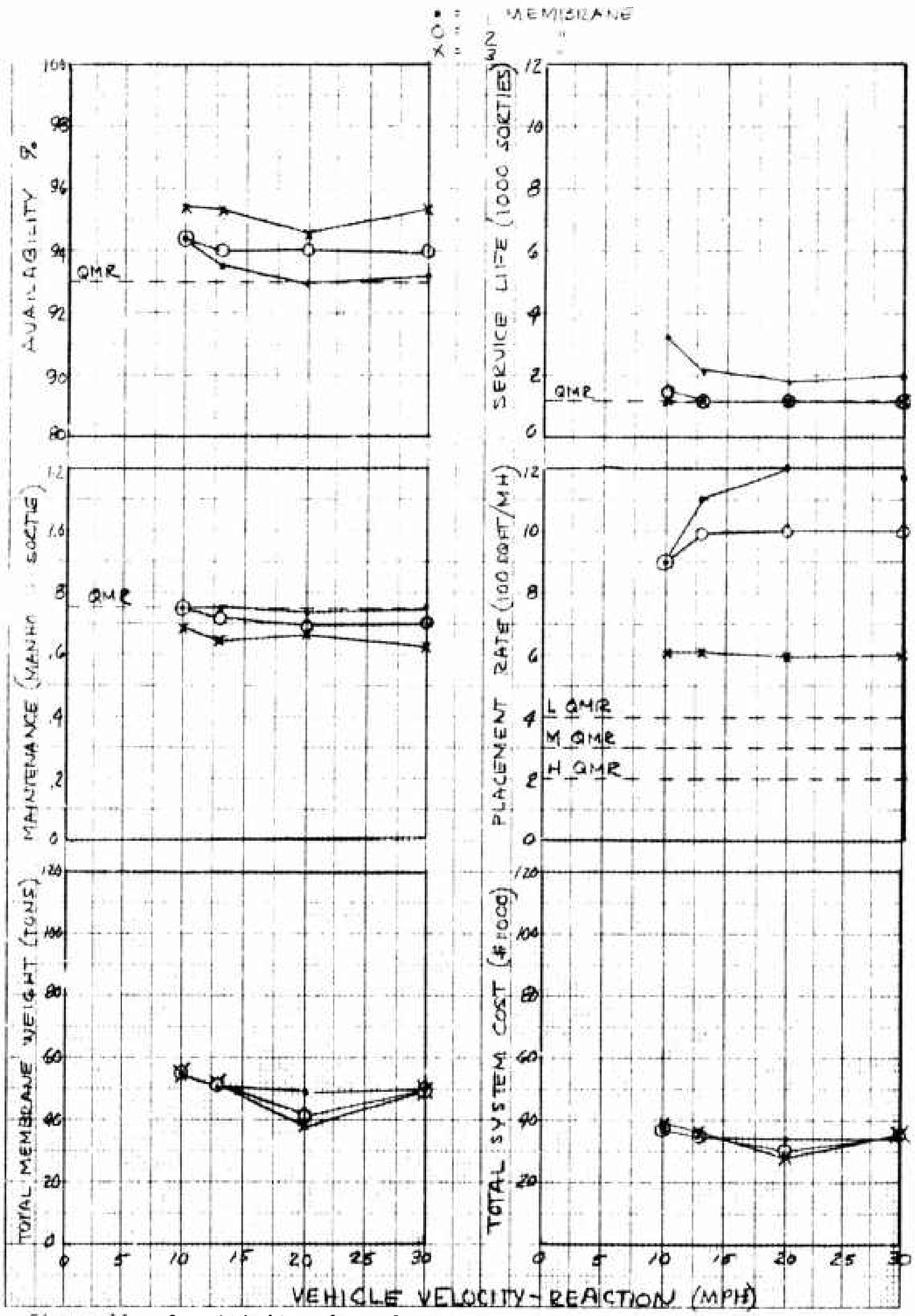

Figure 14. Sensitivity of performance, weight and cost to inspection vehicle velocity (in transit).

142. Runway inspection speeds were varied from 3 to 7 miles per hour. As shown in Figure 15, speeds below 5 miles per hour resulted in substantially increased system weight and cost and decreased availability and placement rate. Speeds of 6 to 7 miles per hour show no improvement. Inspection speeds were set at 5 miles per hour.

Maintenance Crew Size and Number of Crews

143. The size of the inspection-repair crew has a significant effect on system weight and cost (Fig. 16). It is assumed that the entire crew performs the inspection of the membrane so that when damage is found it may be repaired immediately. This means that larger crew sizes consume more man-hours during inspections, allowing fewer man-hours for repairs. Thus, higher membrane strength is required, resulting in higher weight and cost. The minimum effective crew size has been found to be three men (Ref. 2,3,6), which was used in all computations.

144. It is evident from Figure 17 that a more effective way to use more men is to have several crews of three men working simultaneously. This substantially increases availability with only modest increases in system cost and weight. Still the scheme that satisfies the QMR at lowest cost is a single three-man crew.

Placement Crew Size and Number of Crews

145. Since placement rates are in terms of square feet per man-hour, it is evident that the total number of men on the placement detail will not influence placement cost. The cost of transporting the crew to and from the airfield is not considered because it is assumed that part of the airfield construction crew will place the membrane. However, the time required for placement is inversely proportional to the total number of men involved, i.e., with a larger placement crew, the field will become operational sooner (see eq. 51). On an effectiveness basis, however, the ratio of actual placement rate to QMR placement rate is independent of crew size. This is due to the fact that placement rate is a function only of membrane weight (eq. 56). Thus cost and effectiveness are independent of placement crew size.

Adhesive Drying Time

146. The effect of adhesive drying time during membrane repairs was insignificant although system weight and cost

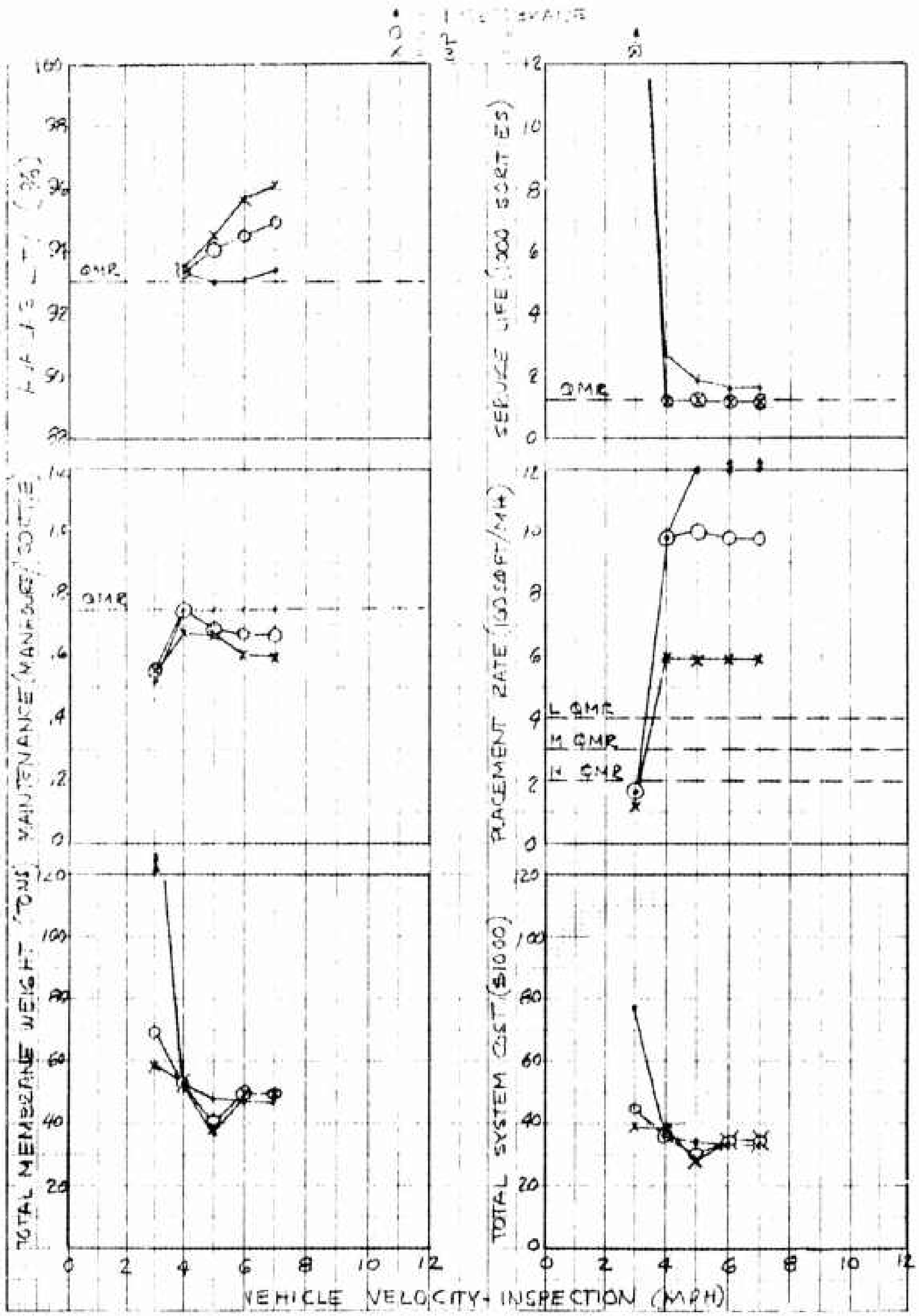

Figure 15. Sensitivity of performance, weight and cost to inspection vehicle velocity (during inspection).

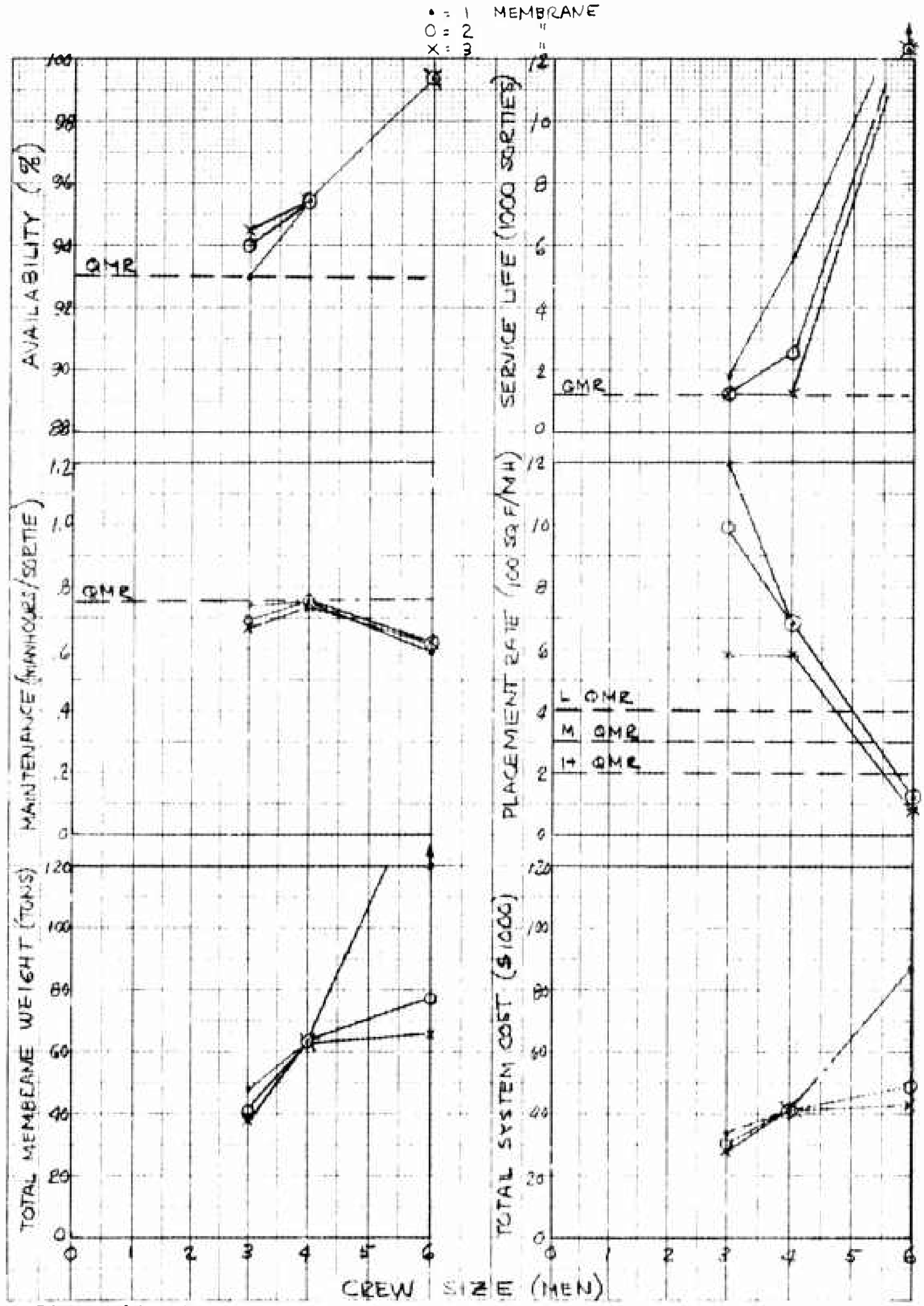

Figure 16. Sensitivity of performance, weight and cost to maintenance crew size.

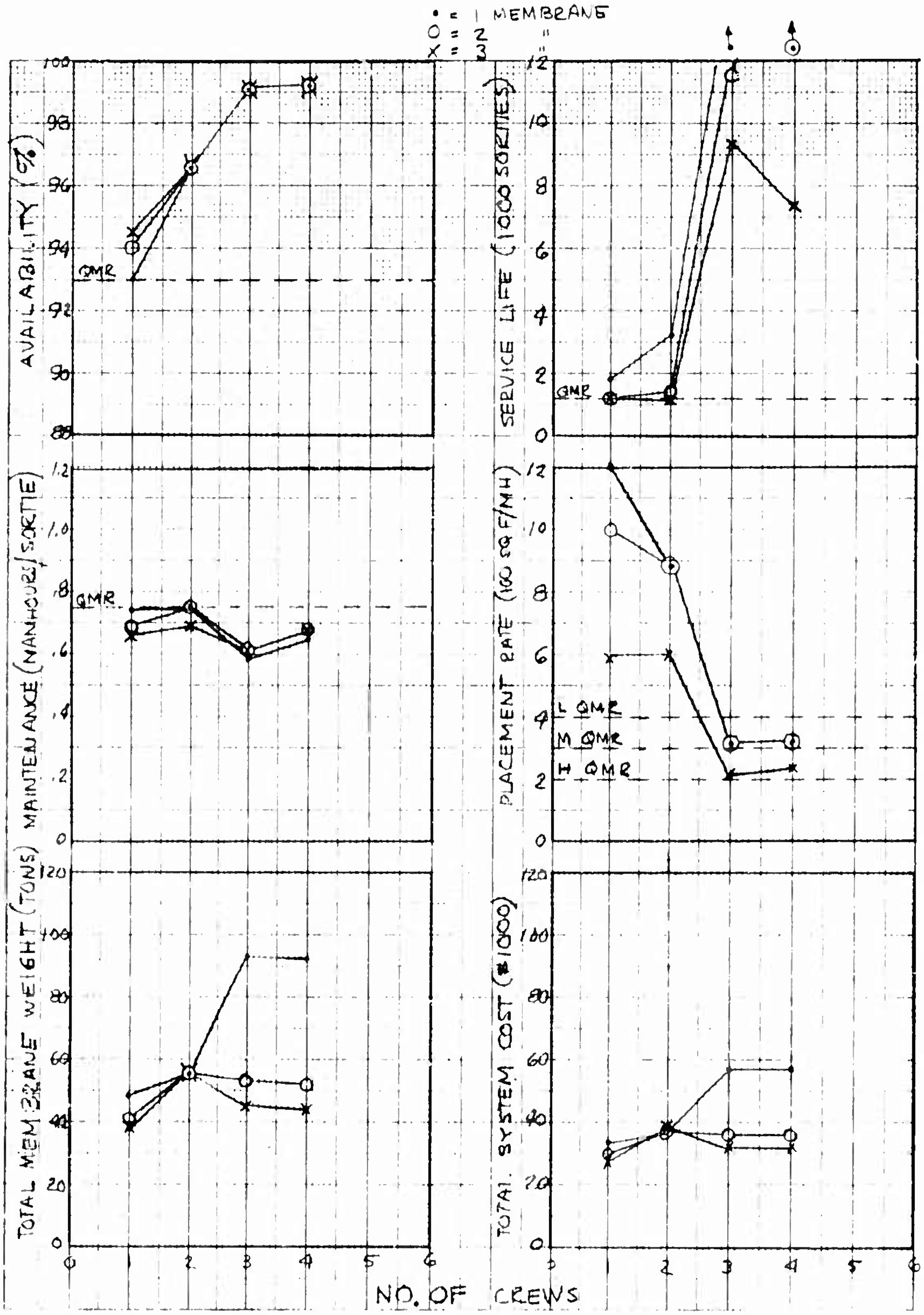

Figure 17. Sensitivity of performance, weight and cost to number of 3-man maintenance crews working simultaneously.

tended to increase slightly, and availability decreased somewhat with increased drying time (Fig. 18). A drying time of 10 minutes was selected as typical for adhesives currently used (Ref. 2).

Maintenance Repair

147. From Figure 19 it is evident that the models are rather insensitive to the man-hours required per repair. There is a slight tendency toward increased weight and cost with increased man-hours per repair. Field experience in Vietnam (Ref. 6) indicates that the average repair requires about 0.6 man-hours of effort and this value was used in the computations.

MEMBRANE SYSTEMS EXAMINED FOR TRAFFIC AREAS

148. The various membrane systems examined in the cost effectiveness analysis are listed in Table 19. These include the suboptimized systems (on a weight basis) from Chapter III, some variations on these systems and systems involving combinations of existing or previously tested membranes. Detailed data for these systems are included in Appendix C. Summarized data for the most promising combinations for shipping by air only are presented in Tables 20, 21, and 22.

ONE-MEMBRANE SYSTEMS

149. The optimum single membrane duty class (i.e., the lightest membrane which will meet requirements on the most severe airfield) is class 21 (Table 15). The only field-tested membrane which approaches this duty class is class 17 (WX-18). A summary of cost-effectiveness data for these two duty classes is presented in Table 20. From Table 16, it is evident that duty class 17 is sufficient for all except support area medium lift fields (C-5A class) in Theaters 3 and 5. For these airfields QMR availability would be met but maintenance would be marginal and the probability of no damage between inspections would fall below 90 percent.

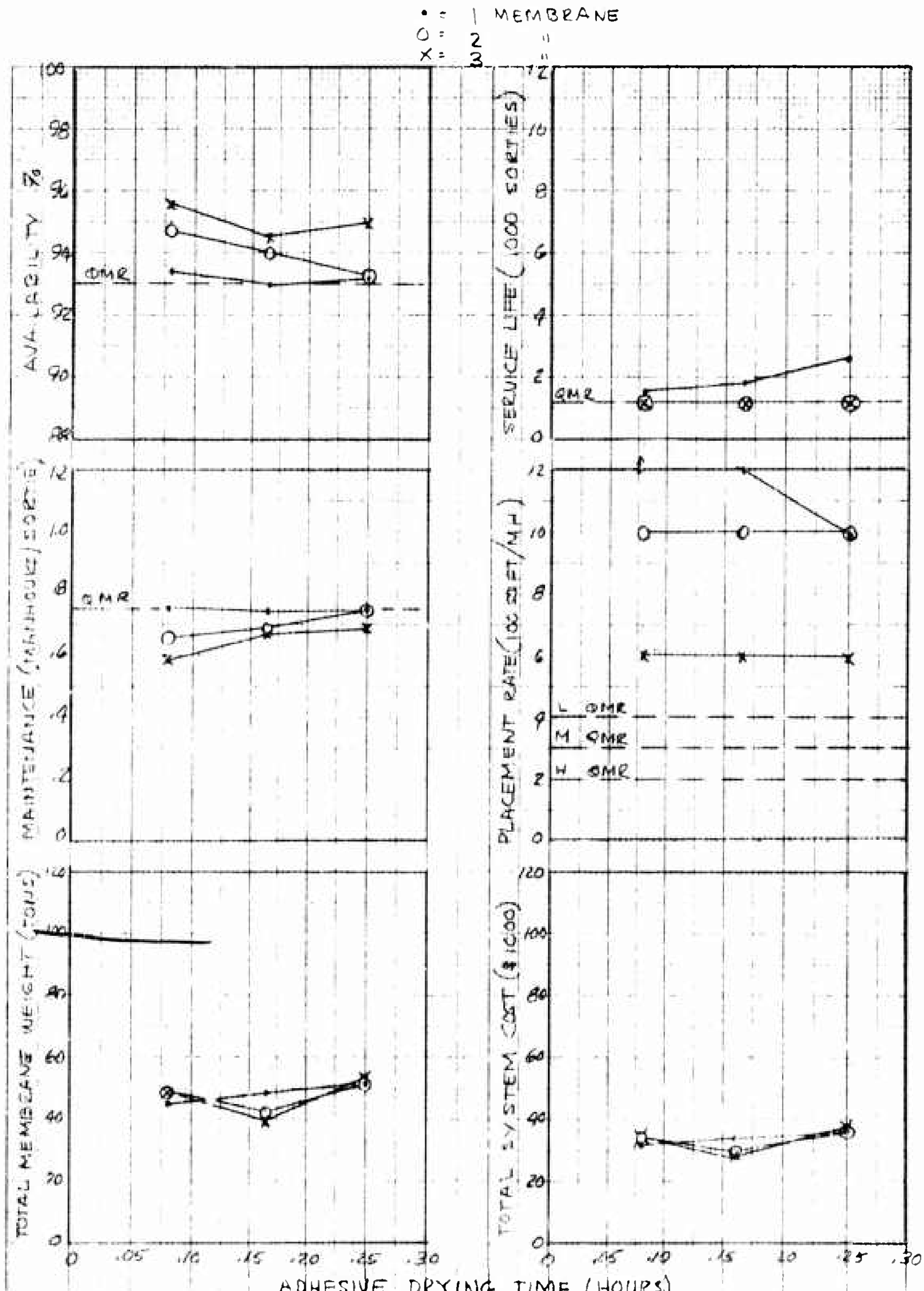

Figure 18. Sensitivity of performance, weight and cost to adhesive drying time.

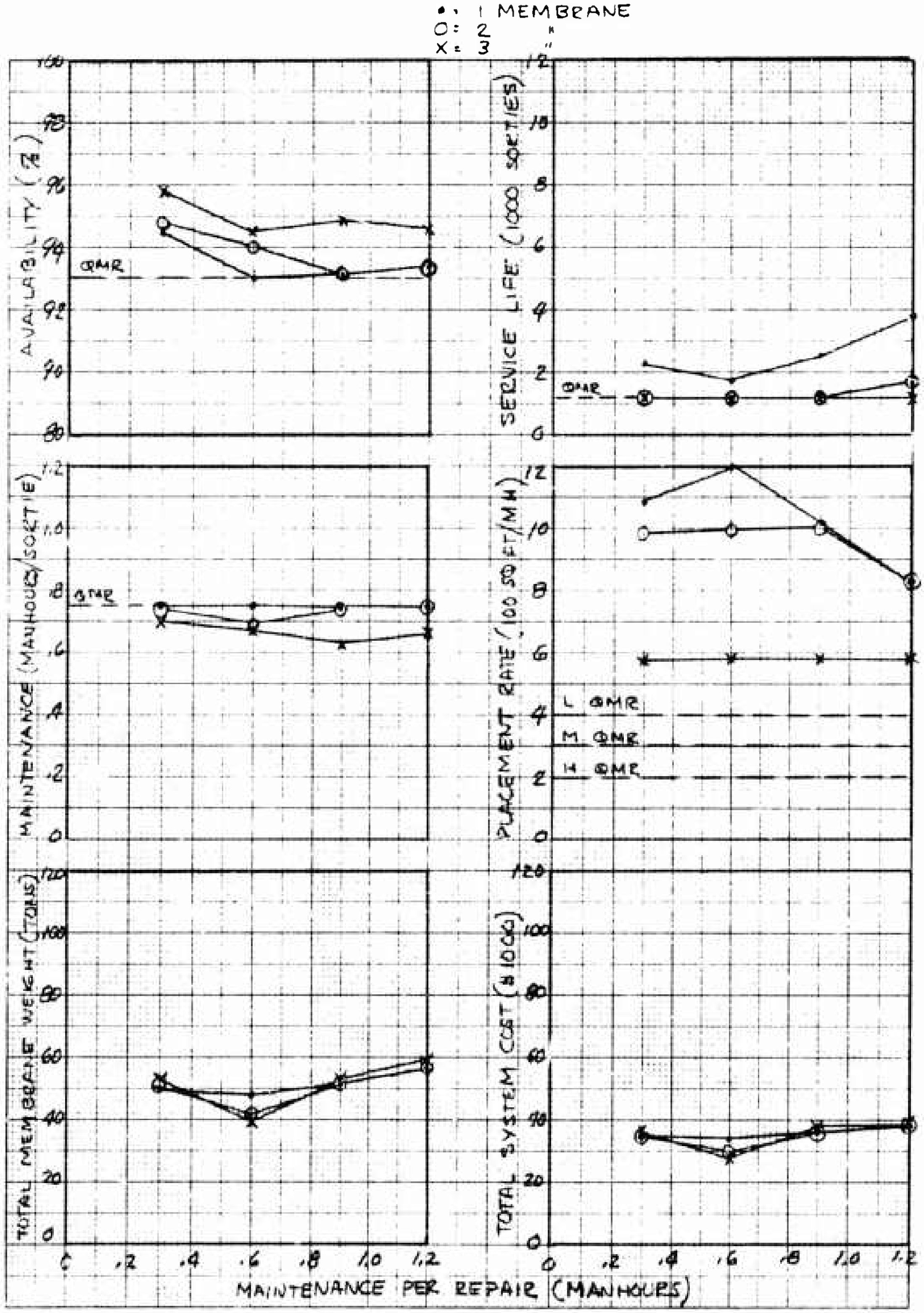

Figure 19. Sensitivity of performance, weight and cost to maintenance effort per repair.

Table 19

Membrane Systems Examined

System Code	Membrane Duty Class		
	Light	Medium	Heavy
1-1	-	-	21
1-2	-	-	17
2-1	7	-	21
2-2	6	-	21
2-3	8	-	21
2-4	10	-	21
2-5	9	-	21
2-6	7	-	17
2-7	10	-	17
2-8 (not used)	-	-	-
2-9	11	-	21
3-1	7	9	21
3-2	7	8	21
3-3	7	10	21
3-4	8	10	21
3-5	7	11	21
3-6	6	9	21
3-7	7	10	17
3-8	5	9	21
3-9	6	10	21
3-10	6	11	21
3-11	8	11	21
3-12	5	10	21
3-13	5	11	21

Table 20

One-Membrane Systems

Class →		21			17		
Theater	Air-field	Effect.	Cost $1000	Cost-effect. $1000	Effect.	Cost $1000	Cost-effect. $1000
1	FAML	1.55	178	114	1.62	117	72
	SAML	1.55	357	229	1.43	239	167
	FAH	1.53	180	117	1.60	121	75
	*Average**		*188*	*122*		*126*	*79*
2	FAML	1.55	168	107	1.62	111	68
	SAML	1.55	352	226	1.42	236	165
	FAH	1.53	167	109	1.60	112	[illegible]
	Average		*175*	*114*		*117*	[illegible]
3	FAML	1.55	176	113	1.62	116	[illegible]
	SAML	1.55	368	237	1.41	247	[illegible]
	FAH	1.53	172	112	1.60	[illegible]	[illegible]
	Average		*184*	*119*		*123*	*77*
4	FAML	1.55	192	123	1.62	127	78
	SAML	1.54	385	248	1.31	258	196
	FAH	1.53	157	102	1.60	105	65
	Average		*163*	*106*		*109*	*68*
5	FAML	1.55	252	162	1.60	167	104
	SAML	1.52	471	309	1.14	318	277
	FAH	1.53	152	98	1.60	101	63
	Average		*188*	*122*		*126*	*83*
	OVERALL AVERAGE		*177*	*115*		*119*	*75*

**Weighted for number of airfields per theater.*

Table 21

Two-Membrane Systems

Classes →		21-10			21-9		
Theater	Air-field	Effect.	Cost $1000	Cost-effect. $1000	Effect.	Cost $1000	Cost-effect. $1000
1	FAML	1.28	63	49	1.27	58	46
	SAML	1.55	357	229	1.55	357	229
	FAH	1.69	72	43	1.63	72	44
	*Average**		*84*	*53*		*83*	*53*
2	FAML	1.27	60	47	1.26	55	44
	SAML	1.59	192	120	1.60	186	116
	FAH	1.69	68	40	1.63	68	41
	Average		*72*	*44*		*72*	*45*
3	FAML	1.62	78	48	1.63	74	45
	SAML	1.59	202	127	1.59	196	122
	FAH	1.69	70	41	1.63	70	42
	Average		*79*	*47*		*78*	*48*
4	FAML	1.17	69	59	1.17	64	55
	SAML	1.58	223	140	1.58	216	136
	FAH	1.69	64	38	1.63	65	39
	Average		*67*	*41*		*67*	*42*
5	FAML	1.58	119	75	1.54	114	73
	SAML	1.55	293	188	1.55	286	184
	FAH	1.69	63	37	1.63	63	38
	Average		*86*	*52*		*85*	*53*
	OVERALL AVERAGE		*76*	*47*		*76*	*47*

**Weighted for number of airfields per theater.*

Table 21 (cont'd.)

Two-Membrane Systems

Classes →		17-10			17-7		
Theater	Air-field	Effect.	Cost $1000	Cost-effect. $1000	Effect.	Cost $1000	Cost-effect. $1000
1	FAML	1.28	63	49	1.24	51	41
	SAML	1.43	239	167	1.43	239	167
	FAH	1.69	72	43	1.46	79	54
	Average		*79*	*50*		*82*	*57*
2	FAML	1.27	60	47	1.62	111	68
	SAML	1.47	160	109	1.50	142	94
	FAH	1.69	68	40	1.46	76	52
	Average		*71*	*44*		*83*	*56*
3	FAML	1.66	70	42	1.40	59	42
	SAML	1.45	168	115	1.49	149	100
	FAH	1.69	70	41	1.46	77	53
	Average		*75*	*45*		*78*	*53*
4	FAML	1.17	69	59	1.62	127	78
	SAML	1.35	182	133	1.38	164	118
	FAH	1.69	64	38	1.46	73	50
	Average		*67*	*41*		*78*	*53*
5	FAML	1.52	104	68	1.64	122	74
	SAML	1.18	233	198	1.20	214	178
	FAH	1.69	63	37	1.46	72	49
	Average		*80*	*52*		*89*	*61*
	OVERALL AVERAGE		*73*	*46*		*81*	*55*

Table 22

Three-Membrane Systems

Classes →		21-9-5			21-9-6		
Theater	Air-field	Effect.	Cost $1000	Cost-effect. $1000	Effect.	Cost $1000	Cost-effect. $1000
1	FAML	1.37	58	42	1.37	58	42
	SAML	1.55	357	229	1.55	357	229
	FAH	1.73	72	41	1.63	72	41
	*Average**		*83*	*51*		*83*	*51*
2	FAML	1.36	55	40	1.36	55	40
	SAML	1.61	167	103	1.60	170	106
	FAH	1.73	68	39	1.63	68	39
	Average		*71*	*42*		*71*	*42*
3	FAML	1.27	62	49	1.29	65	50
	SAML	1.61	175	109	1.60	179	111
	FAH	1.73	70	40	1.63	70	40
	Average		*75*	*45*		*75*	*46*
4	FAML	1.27	64	50	1.27	64	50
	SAML	1.60	216	135	1.59	201	126
	FAH	1.73	65	37	1.63	65	37
	Average		*67*	*40*		*67*	*39*
5	FAML	1.57	104	66	1.57	106	67
	SAML	1.56	264	169	1.55	268	172
	FAH	1.73	63	36	1.63	63	36
	Average		*82*	*49*		*83*	*50*
	OVERALL AVERAGE		*75*	*45*		*75*	*45*

**Weighted for number of airfields per theater.*

Table 22 (cont'd.)

Three-Membrane Systems

Classes →		21-10-5			21-10-6		
Theater	Air-field	Effect.	Cost $1000	Cost-effect. $1000	Effect.	Cost $1000	Cost-effect. $1000
1	FAML	1.36	63	46	1.36	63	46
	SAML	1.55	357	229	1.55	357	229
	FAH	1.77	72	41	1.77	72	41
	Average		*84*	*51*		*84*	*51*
2	FAML	1.35	60	44	1.35	60	44
	SAML	1.61	167	103	1.60	170	106
	FAH	1.77	68	38	1.77	68	38
	Average		*71*	*42*		*71*	*42*
3	FAML	1.27	62	49	1.29	65	50
	SAML	1.61	175	109	1.60	179	111
	FAH	1.77	70	39	1.77	70	39
	Average		*75*	*45*		*75*	*45*
4	FAML	1.25	69	55	1.25	69	55
	SAML	1.60	223	139	1.59	201	126
	FAH	1.77	64	36	1.77	64	36
	Average		*67*	*39*		*67*	*39*
5	FAML	1.61	106	66	1.61	108	67
	SAML	1.56	254	169	1.55	268	172
	FAH	1.77	63	35	1.77	63	35
	Average		*82*	*48*		*83*	*49*
	OVERALL AVERAGE		*75*	*44*		*75*	*44*

Table 22 (cont'd.)

Three-Membrane Systems

Classes →		17-10-7		
Theater	Air-field	Effect.	Cost $1000	Cost-effect. $1000
1	FAML	1.24	51	41
	SAML	1.43	239	167
	FAH	1.46	79	54
	Average		***82***	***57***
2	FAML	1.35	60	44
	SAML	1.50	142	94
	FAH	1.46	76	52
	Average		***77***	***53***
3	FAML	1.40	59	42
	SAML	1.49	149	100
	FAH	1.46	77	53
	Average		***78***	***53***
4	FAML	1.25	69	55
	SAML	1.38	164	118
	FAH	1.46	73	50
	Average		***74***	***51***
5	FAML	1.58	96	60
	SAML	1.20	214	178
	FAH	1.46	72	49
	Average		***84***	***58***
	OVERALL AVERAGE		***78***	***54***

TWO-MEMBRANE SYSTEMS

150. A summary of cost-effectiveness data for seven different two-membrane systems is presented in Table 21. The most cost-effective two-membrane systems are classes 21-9 and 21-10, which are nearly identical in total cost and effectiveness. Preference is given to the 21-10 combination because it includes existing T-17 membrane. The 17-10 combination (WX-18 and T-17) would be optimum except for the restrictions on SAML fields in two theaters (see par. 149).

THREE-MEMBRANE SYSTEMS

151. The cost and cost-effectiveness numbers indicate that the best three-membrane systems (Table 22) are 21-10-5 and 21-10-6, which are very nearly identical. Perhaps preference should be given to the 21-10-6 combination since duty class 6 is nearly equivalent to the strength of T-12 membrane (class 10 corresponds with T-17 in both cases). Close runners-up for a second candidate system are the nearly identifical 21-9-5 and 21-9-6 combinations. If the limitations imposed by class 17 membrane on SAML airfields in two theaters (par. 149) are acceptable, then classes 17-10-7 (WX-18, T-17, T-12) would constitute a less desirable third choice.

EXTRA-LIGHT DUTY CLASS FOR NON-TRAFFIC AREAS

152. As discussed in Chapter III, paragraph 120, a separate extra-light duty class is contemplated for use under landing mat and on non-traffic areas. The specific characteristics of this class require additional study, but strength, weight, and cost will be considerably less than for the lightest acceptable duty class for traffic areas.

VI. MEMBRANE DEVELOPMENT PLAN (PHASE III)

THE QUESTION

153. In answer to the basic question posed by the study objective, the results of Phase II (Chap. V) clearly indicate that a family of membranes will significantly reduce tonnage and overall cost of membrane and accessories required to provide expedient surfacings for airfields in theaters of operation. For airfield traffic areas, the best two-membrane system (classes 21 and 10) offers a 57 percent reduction in cost and a 62 percent reduction in tonnage when compared with the optimum single-membrane system (class 21). The optimum three-membrane system (class 21-10-6) offers a 58 percent reduction in cost and a 63 percent reduction in tonnage when compared with the single-membrane system; and compared with the two-membrane system, the reduction in cost and tonnage is 1.2 percent and 1.7 percent, respectively. The only question remaining is whether to adopt the two- or three-membrane system since the difference between them is small.

CONSIDERATIONS

154. The choice of a two- or three-membrane system is complicated by several factors:

a) No attention has been given to the disadvantages or increased logistical costs involved in storing, issuing, and maintaining multi-membrane systems. It was assumed at the outset that these effects would be small and therefore negligible.

b) If the inspection policy is relaxed on only two support area medium lift airfields out of 36 airfields in all theaters, both the two-membrane and three-membrane systems could be made up entirely of current and previous membranes, i.e., classes 17 and 10 (WX-18, T-17) or classes 17, 10, and 7 (WX-18, T-17, T-12). The three-membrane system would cost about 7 percent more than the two-membrane system.

c) A point to consider with regard to lowering the heaviest duty class from 21 to 17 on the support area airfields is that the 24-wheel main gear of the C-5A aircraft may impose higher loading on the membrane than that predicted by the TECOM formula (par. 20).

d) The placement rate for class 17 (WX-18) is marginal when compared with the QMR. For class 21, the placement rate would clearly not meet the QMR unless a new material is found with the same strength but lighter weight.

e) Class 21 would be more applicable for emergency use on rear area fields (normally mat covered) than class 17.

f) The three-membrane system offers a 3.5 percent savings in cost over the two-membrane system in Theater 5 and a 5 percent savings in Theater 3. These theaters are representative of limited and anti-guerrilla warfare likely to be encountered in the 1975 time frame.

155. The following assumptions will be made:

a) The difference in logistical costs between a three-membrane system and a two-membrane system is negligible.

b) Currently available membranes should be used if possible.

c) Inspection policy should not be compromised.

d) Difference in cost between the two-membrane and three-membrane systems is significant in Theaters 3 and 5.

THE ANSWER

156. With regard for traffic areas and all the considerations discussed above, there is no distinct advantage in the three-membrane system over the two-membrane system when overall theater results are considered. When considered on an individual theater basis, the three-membrane system offers a significant reduction in cost in two theaters. Therefore, a three-membrane system with characteristics listed in Table 23 is recommended. Until suitable heavy and light duty membranes are developed, WX-18 and T-12 may be used as replacements for classes 21 and 6, respectively.

OTHER MATERIALS

157. Since most of the field experience upon which this study is based was obtained with neoprene-coated nylon fabrics, the relative merits of different fabrics or coatings cannot be determined directly. However, neoprene-coated nylon is the most suitable membrane material tested to date at WES and the only one which has been type-classified as Standard A by the Department of the Army.

Table 23

Recommended Three-Membrane System

Duty Class	Tensile Strength *(lb/in)*	Weight *(lb/sq yd)*	Remarks
(21) Heavy	3000-3100	<6	Requires R&D
(10) Medium	900-1000	<4	T-17 or equivalent
(6) Light	550-650	<2	Requires R&D, $\leq$ T-12

158. To assist in evaluating a candidate membrane material, a tradeoff curve of initial cost versus weight (Fig. 20) has been developed for membrane duty class 21 when applied to support area airfields in Theater 3. The line of equal total cost effectiveness indicates how much one can afford to pay for materials of various weights but with strength and performance comparable to duty class 21. Materials which fall on (or near) the line are essentially equivalent to a neoprene-coated nylon fabric of duty class 21. Those which are represented by a point to the left or below the line by a substantial margin are "good buys," while those to the right or above the line are poor investments.

159. A noteworthy observation, based on the limited data presented in Appendix D, is that for a given membrane strength multiple plies of lightweight fabric appear to be less expensive than a single ply of heavy fabric.

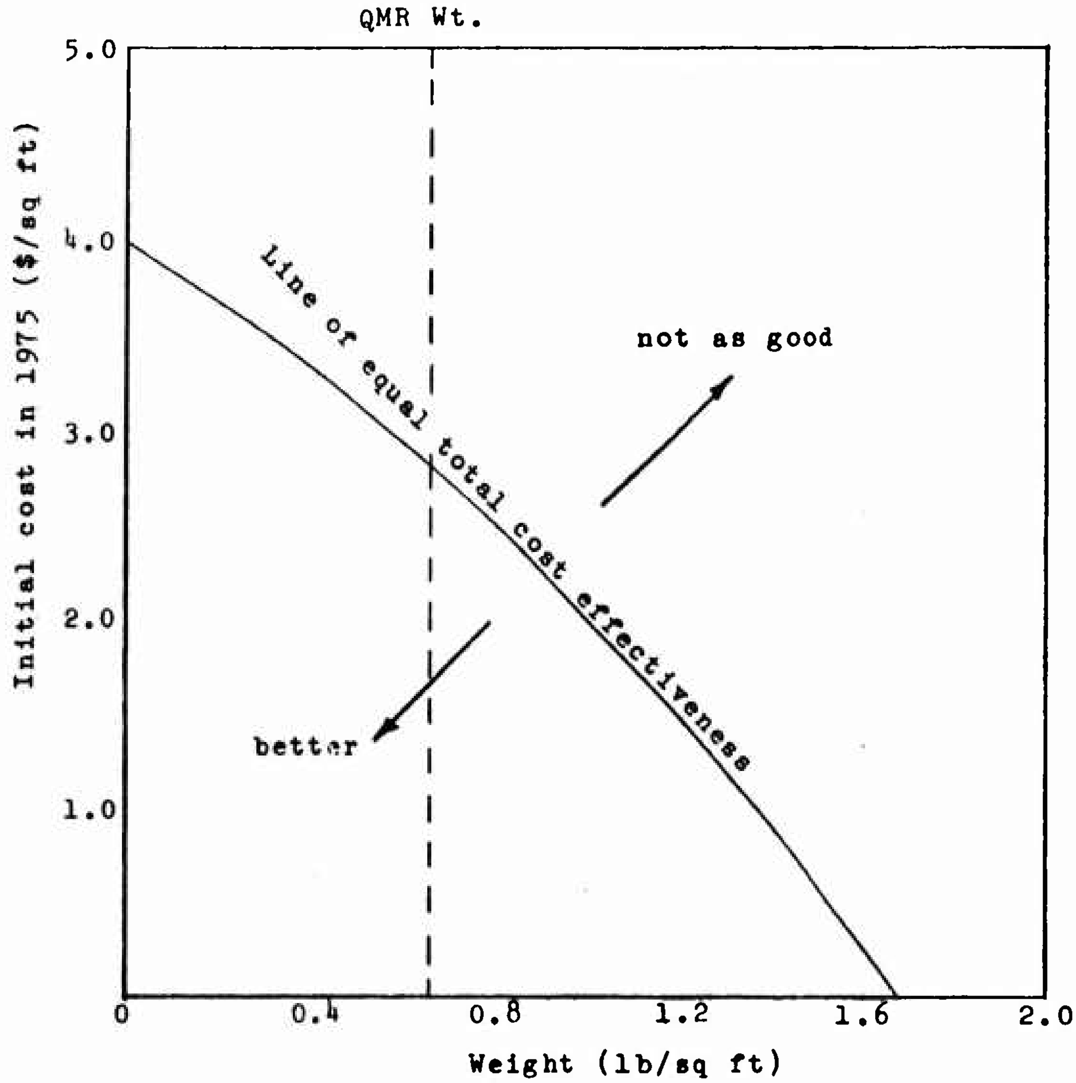

Figure 20. Initial cost vs. weight trade-off for materials equivalent to Heavy Duty (class 21) neoprene-coated nylon fabric membranes (for Support Area Medium Lift Field in Theater 3).

VII. SUMMARY

160. Prefabricated membrane surfacings provide the Army with a rapid means of waterproofing and dustproofing airfield runways, taxiways, parking areas, helipads, and airfield roads. The membrane may be used for this purpose under landing mats or, where soil strength is adequate, as the main wearing surface. Use of the membrane enables in-situ soil strength to be maintained, reducing airfield construction and maintenance effort required, and provides dust control, reducing safety hazards to aircraft operation and airfield detection.

161. Since World War II, prefabricated membranes of several designs, materials, weights, and strengths have reached various stages of development from simple laboratory tests to field use. One, T-17, has been type-classified as Standard A by the Department of the Army and has seen service in Vietnam. A DA approved QMR for Prefabricated Airfield Surfacings has been developed which lists the desired functional characteristics of three classes of membranes. The objective of this study was to provide a basis for deciding whether to develop a family of membranes of various weights, or a single membrane of optimum weight, to satisfy military requirements for membrane as set forth in the QMR.

162. To accomplish the overall objective, the study was divided into three major phases:

a) Phase I - a trade-off analysis to determine the effect on membrane cost and mission effectiveness resulting from specific changes to the QMR.

b) Phase II - a cost effectiveness analysis to determine the most cost effective membrane, or combination, from those currently available that are capable of satisfying the QMR.

c) Phase III - a membrane development plan to meet the study objective.

163. Three families of membranes involving one, two, and three membrane weights (duty classes), respectively, were examined for use on airfield traffic areas. Each family was optimized for five theater scenarios. Three alternative policies for deploying a given optimum family on a given class of airfield were considered by dividing the airfield into three sub-areas: runway ends, runway center, and taxi-park. A fourth duty class was considered for use on non-traffic areas and under landing mats.

164. Data on membrane performance, airfields, and aircraft were obtained from technical bulletins, manuals, and data packages supplied by WES. Standard planning rates for military personnel costs and shipping costs were supplied by AMC. Data on five theater scenarios were obtained from CDC. Where required data were not available, estimates and assumptions were made necessary and indicated as such.

165. The criteria for membrane effectiveness were based on a suboptimization at the airfield effectiveness level, without feedback into larger aerial surveillance, transport, and/or combat systems. Membrane effectiveness was defined in terms of availability, placement rate, and service life, weighted seven, two, and one, respectively.

166. From the available data, mathematical models were developed for membrane performance, runway downtime, availability, inspection frequency, maintenance man-hours, placement rate, service life, effectiveness, and life cycle costs, including initial, shipping (air and surface mode), placement, maintenance, recovery, and retroshipment costs. Appropriate computer programs were developed to provide the required information on required membrane areas, tonnage, effectiveness, costs, and cost effectiveness for one-, two-, and three-membrane systems in five theaters of operation.

167. Minimum membrane strengths necessary to meet QMR availability, maintenance man-hours, and service life were calculated for one-, two-, and three-membrane families with three different deployment plans for each airfield in each theater of operations. Placement rate was considered to be dependent upon the weight associated with the minimum required strength. The total number of membrane strengths required was divided into 21 numbered classes.

168. Suboptimized one-, two-, and three-membrane systems were selected by determining the membrane combinations which resulted in minimum overall system weight. These were class 21, classes 21 and 7, and classes 21, 9, and 7. Since most membrane cost elements are a function of weight, this suboptimization effectively reduced the number of duty classes to be examined to a small number of perturbations about the three systems. The optimum one-, two-, and three-membrane systems for airfield and heliport traffic areas were class 21, class 21-10, and class 21-10-6, respectively. The optimum two-membrane system offered a 57 percent reduction in cost and a 62 percent reduction in tonnage when compared to the single-membrane system. There was no significant difference in cost and effectiveness between the two- and three-membrane systems when considered

on an overall theater basis. When considered on an individual theater basis, however, the cost saving of class 21-10-6 over 21-10 rose to 3.5 percent for Theater 5, and 5 percent for Theater 3. This was considered to be a significant difference, especially since these theaters are typical of limited and anti-guerrilla warfare which may be encountered in the 1975 time frame. Therefore, a three-membrane system, classes 21, 10, and 6, was recommended for traffic areas.

169. Class 21, with a mean tensile strength of 3000 to 3100 pounds per inch, has not been developed. Until class 21 becomes available, class 17 (equivalent to existing WX-18) may be used. Class 10 is equivalent to the Standard A membrane, T-17. Class 6 is very nearly equivalent to a former experimental membrane, T-12. Additional research is needed to establish a performance model for extra-light duty membrane for use in non-traffic areas and under landing mat. However, past experience has indicated that this duty class need not exceed class 3 (equivalent to T-16).

170. In conclusion, the results of this study clearly indicate that significant savings in membrane system costs can be realized by adopting a family of membranes rather than a single membrane of optimum weight.

171. It is recommended that development continue on the three-membrane system for traffic areas as outlined above. It is also recommended that research and development begin on an extra-light duty membrane for use on non-traffic areas and under landing mats.

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APPENDIX A

QUALITATIVE MATERIEL REQUIREMENT FOR PREFABRICATED AIRFIELD SURFACINGS

Department of the Army Approved
Qualitative Materiel Requirements
for Prefabricated Airfield Surfacings

Section I - Statement of Requirement

1. Statement of Requirement

Prefabricated or expedient airfield surfacings are required to provide the Army with improved capability to produce the required aircraft landing facilities, in theaters of operation, which are essential for support of air mobility concepts. Economy in logistics and costs and flexibility in design of landing facilities can best be provided by development of mats and membranes. The landing mats will provide a bearing surface capable of supporting specified aircraft loadings on low strength soils. Use of the matting will greatly reduce the time and engineer effort required to construct airfields by substantially reducing the need for subgrade preparation and by providing a surface which can be rapidly emplaced. The membranes will provide a rapid means of waterproofing and dustproofing runways and taxiways in areas where soil strength is adequate and of waterproofing subgrades beneath landing mats. Use of the membranes will enable in-situ soil strength to be maintained, reducing airfield construction and maintenance effort required, and provide dust control, reducing safety hazards to aircraft operation and airfield detection. It is desirable that these membrane requirements be met by a single membrane. All surfacings will be lightweight, consistent with meeting operational requirements, reusable without

rehabilitation if undamaged, and packaged for ease of handling. The landing mats and membranes will be of such superiority to warrant replacement of current standard items. Army engineer units or groups of indigenous personnel under Army engineer supervision will use the surfacings to improve existing airfields or to construct new airfields in all areas of the world where operations require airfield support. (TF: 70) (CDOG para 639b (2)) (Approved 14 Apr 66)

Section II - Operational, Organizational and Logistical Concepts

2. Operational Concepts

a. Requirements. The proposed airfield surfacings will provide rapid means for preparing and/or improving airfields and landing areas capable of accommodating all types of aircraft in support of military operations including strategic and tactical lift (inter-theater and intra-theater), and tactical air support. The surfaces must provide all-weather operational capability and be capable of installation during all times except when the proper subgrade conditions cannot be obtained or maintained. The landing mat must be capable of providing operational surfacing for two weeks or 500 sorties (sortie - one takeoff and one landing) without failure. A typical daily 24-hour mission for an airfield is 36 sorties. The membrane must be capable of providing operational surfacing for two weeks or 100 sorties without failure. A typical daily 24-hour mission for a membrane surfaced airfield is seven sorties. The method of construction and materials used will provide for the suppression of dust to the extent that visual detection and adverse effects on aircraft maintenance will be reduced.

b. Operational Information.

(1) Planned deployment. The proposed materiel is essential to the successful conduct of air operation within any theater of operations. The airfield surfacings may be utilized to support air operations in any land area of the world; however, primary use is expected to be in the underdeveloped areas where airfields are either nonexistent or inadequate. The surfacing will also be used to repair damage of existing airfields with like surfacings. Adoption of this materiel will provide significant reductions in logistical tonnages and man-hours of installation and maintenance effort required. The proposed surfacings will be installed primarily by Army engineer combat and construction battalions or trained indigenous personnel, under supervision of Army engineers.

(2) Turnaround time. Predicted turnaround time is unknown. Turnaround time is the time needed to remove, inspect for reuse, reprovision, and install at another site.

(3) Reaction time. Reaction time is the time needed to inspect the airfield surface to determine if an aircraft can take off or land without damage. The reaction time will not exceed ten minutes per landing or takeoff. Normally, the suitability of the airfield to perform a typical 24-hour mission will be determined during a daily (1 hour essential) (30 minutes desired) visual inspection of the runway surface. The daily visual inspection will be performed from a moving ground vehicle driving up one side and down the other side of the runway with intermediate stops as necessary.

(4) Service life. The surfacing will have a service life of not less than six months or equivalent sorties with not more than a 10 percent replacement of materiel due to failures.

(5) Availability. It is desired that operational availability be at least 93 percent, with 15 percent replacement parts (AR 700-19).

(6) Reliability. The materiel shall demonstrate a Mean Time Between Failures (MTBF) of not less than two weeks or equivalent sorties. A failure is defined for the purposes of computing MTBF as a repair necessary to restore performance to within limits indicated herein and requiring greater than 24 man-hours of total effort by personnel from an Engineer Platoon of the Airmobile Divisional Engineer Battalion.

(7) Durability. Surfacing materiel shall without failure complete the following initial operations requirement of 500 sorties for mat and 100 sorties for membrane.

3. Organizational and Logistical Concepts

a. The size and numbers of the installing crews will be consistent with construction requirements and the time factors dictated by operational requirements.

b. The proposed surfacings will be Class IV supply items.

c. Specific quantities required will be determined after completion of the current U. S. Army Combat Developments Command Study, Airfield Construction Requirements, Theater of Operations 1967-1970.

Section III - Justification, Feasibility and Priority

4. Reason for the Requirement

The requirements for air support to ground combat operations have increased significantly and are continuing to grow. Present planning in both general and limited war situations, and for sustained ground, airborne and airmobile operations, call for an unprecedented volume of Air Force and Army aircraft for such air missions as inter-theater strategic lift, close tactical support, air assault operations, intra-theater airlift in an air line of communications (ALOC), and intra-division airlift to front line units. Additionally, the concept of total air mobility as developed by the Army Tactical Mobility Requirements Board will create many new aircraft missions within the front line division area. Current Army construction capabilities in support of these concepts are not compatible with requirements in terms of time and geographical areas of employment. Concepts dictate that airfields be readied in the early stages of troop deployment in airmobile operations and that airfields be located in proximity to the supported forces thereby ensuring that the mobility of the Army force is consistent with strategic and tactical objectives. Current airfield surfacing methods require either the selection of a site where the CBR of the soil will sustain aircraft loadings or the extensive preparation of the subgrade to achieve necessary soil strengths. In many areas of the world where deployment of U. S. airmobile forces is foreseen, required airfields do not exist, are too few in number, or cannot sustain the loadings of

supporting aircraft. Also, construction materials for preparation of airfield subgrades and surface are not available or necessitate disproportionate demands for time and effort to locate, process, transport, emplace and compact granular materials for airfield base construction. Current military systems (PSP, M6, M8, and M9 mats) due to weight and load bearing characteristics and conventional methods of constructing airfields do not permit the development of air landing facilities for airborne and airmobile forces throughout the world on a selective basis within envisioned time parameters. Without the construction capability to support airborne and airmobile forces their employment is seriously jeopardized if not totally prevented. This proposed system will facilitate the construction envisaged.

a. The time phasing of this requirement is immediate in relationship to present material and capabilities. This requirement satisfies immediate and long-range objectives.

b. The requirement for this type materiel is supported in CDOG paragraph 639b(2).

c. References which support this requirement are:

(1) U. S. Army Tactical Mobility Requirements Board Final Report, August 1962.

(2) Final Report of Joint Exercise SWIFT STRIKE III, 20 November 1963.

(3) Army Air Mobile Evaluation, Headquarters, U. S. Army Combat Developments Command, 15 February 1965.

5. Technical Feasibility

It is technically feasible, as stated in Appendix I, to develop the airfield surfacings which will satisfy the requirements of this QMR.

6. Priority

This QMR is assigned Priority I, functional group 4 Tactical Movement, Appendix C, CDOG.

Section IV - Characteristics

7. Performance Characteristics

a. It is essential that the landing mats for the various classifications:

(1) Be capable of being directly installed upon graded subgrades.

(2) Be capable of withstanding the aircraft loading conditions shown on Incls 1 and 2.

(3) Be capable of withstanding coverages and loads shown on Incls 1 and 2, with a maximum of 10 percent replacement.

(4) Be capable of:

a. Heavy duty mats will withstand aircraft operations to include maximum takeoffs using afterburner. These mats shall withstand blast effects of 700 F for 10 seconds.

b. Medium duty mats will withstand aircraft operations to include maximum takeoffs using afterburner. These mats shall withstand blast effects of 300 F for 5 seconds.

c. Light duty mats shall withstand C-130 aircraft assault landings utilizing maximum wheel braking and reverse thrust procedures.

d. Surfacing at locations of arresting cables and arresting hook impacts are subject to unusual loadings and impact effects and are considered critical areas. Special surfacing will be provided when heavy and medium duty mats do not meet the requirements listed below for critical areas of runways surfaced with heavy or medium duty mats.

1. Surfacing for critical areas of heavy duty mat surfaced runways will withstand five F4 tailhook impacts of 80 knots at equivalent 18 FPS sink speed at the same location without structural failure due to rupture of the top surface of the mat.

2. Surfacing for critical areas of heavy duty mat surfaced runways will withstand 20 roll-over loadings on a 1-in.-diam arresting cable with a 50,000-lb wheel load, having a nominal tire contact area of 200 sq in. and a tire-inflation pressure of 250 psi, without structural failure due to rupture of the top surface of the mat.

3. Surfacing for critical areas of medium duty mat surfaced runways will withstand two F4 tailhook impacts of 80 knots at equivalent 18 FPS sink speed at the same location without structural failure due to rupture of the top surface of the mat.

4. Surfacing for critical areas of medium duty mat surfaced runways will withstand 20 roll-over loadings on a 1-in.-diam arresting cable with a 25,000-lb wheel load, having a nominal tire-contact area of 100 sq in. and tire-inflation pressure of 250 psi without structural failure due to rupture of the top surface of the mat.

(5) Be so designed so as to not cause damage to waterproofing or dustproofing treatment applied to the subgrade, or desirably, inherently provide waterproofing and dustproofing of the underlying soil surface.

(6) Be capable of withstanding ambient temperature variations in accordance with paragraph 7c of AR 705-15, change 1, without deformation of such magnitude as to interfere with assembly and operations.

(7) Possess a surface which provides effective braking with a Runway Condition Reading (RCR) of 13-25 for aircraft landings and control during all ground operations, under conditions specified in AFR 60-13 and in paragraph 7a, b, and c of AR 705-15, change 1.

(8) Resist adverse effects, when installed operationally, resulting from exposure to POL spillage, downwash from helicopters, and wheel vehicle traffic.

(9) Be capable of storage and air transit under conditions stated in paragraph 7.1a, b, and d of AR 705-15, change 1: for closed storage, ten years; for open storage, five years without adverse effects upon the system components.

(10) Possess a service life of not less than six months or 6000 sorties with not more than a 10 percent replacement of material due to failures.

(11) Possess an operational availability of at least 93 percent, with 15 percent replacement parts (AR 700-19).

(12) Possess reliability that the Mean Time Between Failures (MTBF) shall be not less than two weeks or 500 sorties. A failure is defined

for the purpose of computing MTBF as a repair necessary to restore performance to within limits indicated herein and requiring greater than 24 man-hours of total effort by personnel from an Engineer Platoon of the Airmobile Divisional Engineer Battalion.

(13) Possess a durability which will enable the mats to sustain 500 sorties of initial operations without failure.

b. It is essential that the membranes:

(1) Be capable of being directly installed upon graded subgrades.

(2) Possess a surface which provides effective braking with a Runway Condition Reading (RCR) of 13-25 for aircraft landings and control during all ground operations, under conditions specified in AFR 60-13 and paragraph 7a, b, and c of AR 705-15, change 1.

(3) Be capable of withstanding wheel loads without destruction of waterproof properties when laid on soils capable of supporting these wheel loads, or when placed underneath landing mat, see Inc. 3.

(4) Resist adverse effects, when installed operationally, resulting from exposure to POL spillage, helicopter downwash, and wheel vehicle traffic.

(5) Be capable of storage and air transit under conditions stated in paragraph 7.1a, b, and d of AR 705-15, change 1: for closed storage, five years; for open storage, three years without adverse effects upon the system components.

(6) Be capable of withstanding ambient temperature variations in accordance with paragraph 7c of AR 705-15, change 1, without elongation or contraction of such magnitude as to interfere with assembly and operations.

(7) Be readily repairable in the field under conditions as specified in paragraph 7a and b of AR 705-15, change 1.

(8) Possess a service life of not less than six months or 1200 sorties with not more than a 10 percent replacement of material due to failure.

(9) Possess an operational availability of at least 93 percent assuming adequate logistical support.

(10) Possess reliability that the Mean Time Between Failures (MTBF) shall be not less than two weeks or 100 sorties. A failure is defined for the purposes of computing MTBF as a repair necessary to restore performance to within limits indicated herein and requiring greater than 24 man-hours of total effort by personnel from a Engineer Platoon of an Airmobile Divisional Engineer Battalion.

(11) Possess a durability which will enable the membrane to sustain initial operations of 100 sorties without failure.

8. Physical Characteristics

a. It is essential that the landing mats:

(1) Be as lightweight as possible consistent with other requirements, and weigh as shown on Incls 1 and 2.

(2) Be capable of installation by trained personnel at the rates shown on Incl 1, Table 3.

(3) Permit replacement of an individual mat panel within two hours essential, one hour desirable.

(4) Be capable of placement with a minimum number of accessories and special tools.

(5) Be provided with a simple method of transition and laying from runway to taxiway and parking aprons.

(6) Be provided with an adequate system of anchoring runways and taxiways to prevent movement, lift, and not cause damage to aircraft tires.

(7) Be capable of being installed directly on graded subgrades with maximum crowns of 3 percent, longitudinal grades of 5 percent, and a maximum longitudinal grade change of 2 percent in 100 ft.

(8) Individual mats be of such size, shape, and weight to be handled by two men (desirable maximum weight - 100 lb, essential maximum weight - 120 lb).

(9) Be packaged so as to compliment ground transportation and installation and for ease of aircraft transportation in accordance with para 5a of AR 705-35.

(10) Be provided with a capability which will allow rapid replacement of buckled (forced together) and forced apart panels in the center of the runway from bomb or other damage.

(11) Be provided with components which will permit joining light duty panels to medium duty panels, and medium duty panels to heavy duty panels.

(12) (Desirable) Be provided with 45-deg transition connector panel which will allow construction of high speed taxiways.

b. It is essential that the membranes:

(1) Be as lightweight as possible as shown on Incl 1, Table 4.

(2) Be capable of being installed by trained personnel at the rates shown on Incl 1, Table 5.

(3) Withstand locked-wheel braking action and maximum wheel braking procedures of critical aircraft.

(4) Be packaged to facilitate hand laying so as to compliment ground transportation and installation and for ease of aircraft transportation in accordance with para 5a of AR 705-35.

(5) Be provided with suitable anchoring devices which will not damage the membrane or tires.

(6) Be capable of being installed directly on graded subgrades with maximum crowns of 3 percent, longitudinal grades of 5 percent, and a maximum longitudinal grade change of 2 percent in 100 ft.

9. Maintenance Characteristics

a. The mats and membranes shall be designed to minimize maintenance. It is essential that maintenance be as follows:

(1) Be designed to facilitate maintenance accessibility in the field environment at all categories so that required maintenance will be performed in the minimum practicable time with a minimum degree of skill, variety of tools, test equipment, and other supplies.

(2) Be designed towards minimization of maintenance by utilization of the most reliable components; modular construction; built-in, simple, failure indicators; and other technological advances in components and/or methods.

(3) Be designed so that individual and/or damaged sections of materials may be removed and replaced.

b. Typical maintenance to restore performance specified herein will consist of but not necessarily be restricted to the following: cleaning, inspecting for repairs, alignment, tightening of anchors, patching, replacement of damaged mat panels, and repair of nonskid surface. Maintenance performed shall not exceed 150 man-hours per month by personnel from an Engineer Platoon of the Airmobile Divisional Engineer Battalion for the service life of the materials. (Subgrade failures are not included in this paragraph.)

10. Human Engineering Characteristics

Human factors engineering characteristics of the system will include consideration of the intellectual, physical and psychomotor capabilities of the intended user.

11. Priority of Characteristics

a. Performance

b. Weight

c. Reliability and Durability

d. Transportability

e. Maintainability

Section V - Personnel and Training Considerations

12. Quantitative and Qualitative Personnel Considerations

a. The system will be installed primarily by Army engineer units. However, its simplicity of emplacement will require a minimum of training

whereby any Army unit, or indigenous personnel, could install and maintain the system.

b. No new MOS will be required.

c. Although a savings in personnel strengths normally associated with airfield construction may not be effected, with this system the troop effort required to prepare base courses can be diverted to other tasks, and the overall airfield construction time reduced.

13. Training Considerations

Training for actual installation and maintenance of this system will be negligible. Preparation of the ground for installation of this system will normally be by Army engineer units which already have this capability. Training literature on the repair and reuse of prefabricated airfield surfacing materials is required. This literature should cover the factors to be considered in evaluation of surfacing for reuse, evaluation methods and procedures, repair techniques and methods, repackaging information, and a basis of classification of prefabricated airfield surfacing materials for future use.

Section VI - Associated Considerations

14. Training Devices

None required. Components of the system will be utilized for training.

15. Related Materiel

No change in present items of supply is anticipated. Similar items of supply already in the Army supply system may still be required to support

Army aircraft operations. It is not intended that this system be capable of inter-mix usage with current standard, similar items of supply, although this would be desirable if it could be done with no compromise of capability in the proposed system. Ancillary equipment and special tools to emplace, use, and maintain prefabricated airfield surfacings must be developed as required.

16. Concealment and Deception

Normal camouflage considerations apply; reduction in light reflectivity is required. No disguise or simulation devices are required.

17. Interest

This system will probably be of interest to British, Canadian, and Australian Armies.

18. Current Inventory Items

There are no existing items, and no items are under development by other services or allied armies which can fulfill this requirement.

19. Communications Security

None.

20. Additional Comments

a. If, during the development phase, it appears to the developing agency that the characteristics listed herein require the incorporation of certain impracticable features and/or unnecessarily expensive and complicated components or devices, costly manufacturing methods or processes, critical materials or restrictive specifications which will prove excessively expensive or serve as a detriment to the military value of the unit, such

matters shall be brought to the immediate attention of the Chief of Research and Development of the Army, and Headquarters, U. S. Army Combat Developments Command for consideration before incorporation into a final design.

b. This materiel requirement is identified by USACDC Action Control No. 7494 and supports the following:

(1) Army Concept Program Army 75

(2) Study "Engineer 75";

USACDC Action Control No. 6493

(3) Army Tasks	1: High Intensity Conflict 2: Mid Intensity Conflict 3: Low Intensity Conflict, Type I 4: Low Intensity Conflict, Type II 6: Military Aid to U. S. Civil Authorities 7. Complementing of Allied Land Power
(4) Phase	Materiel
(5) Function	Service Support

Table 1

Mat Classification	Single-Wheel Load, lb	Tire Pressure psi	Nominal Contact Area, sq in.	Coverage Level	CBR
Heavy duty	50,000	250	200	1000	4
Medium duty	25,000	250	100	1000	4
Light duty	30,000	100	300	1000	4

Table 2

Mat Classification	Desirable Weight lb per sq ft	Essential Weight lb per sq ft
Heavy duty	5.0	6.5
Medium duty	4.0	4.5
Light duty	2.5	3.0

Table 3

Mat Classification	Desirable Placing Rate sq ft per man-hour	Essential Placing Rate sq ft per man-hour
Heavy duty	400	150
Medium duty	400	250
Light duty	600	400

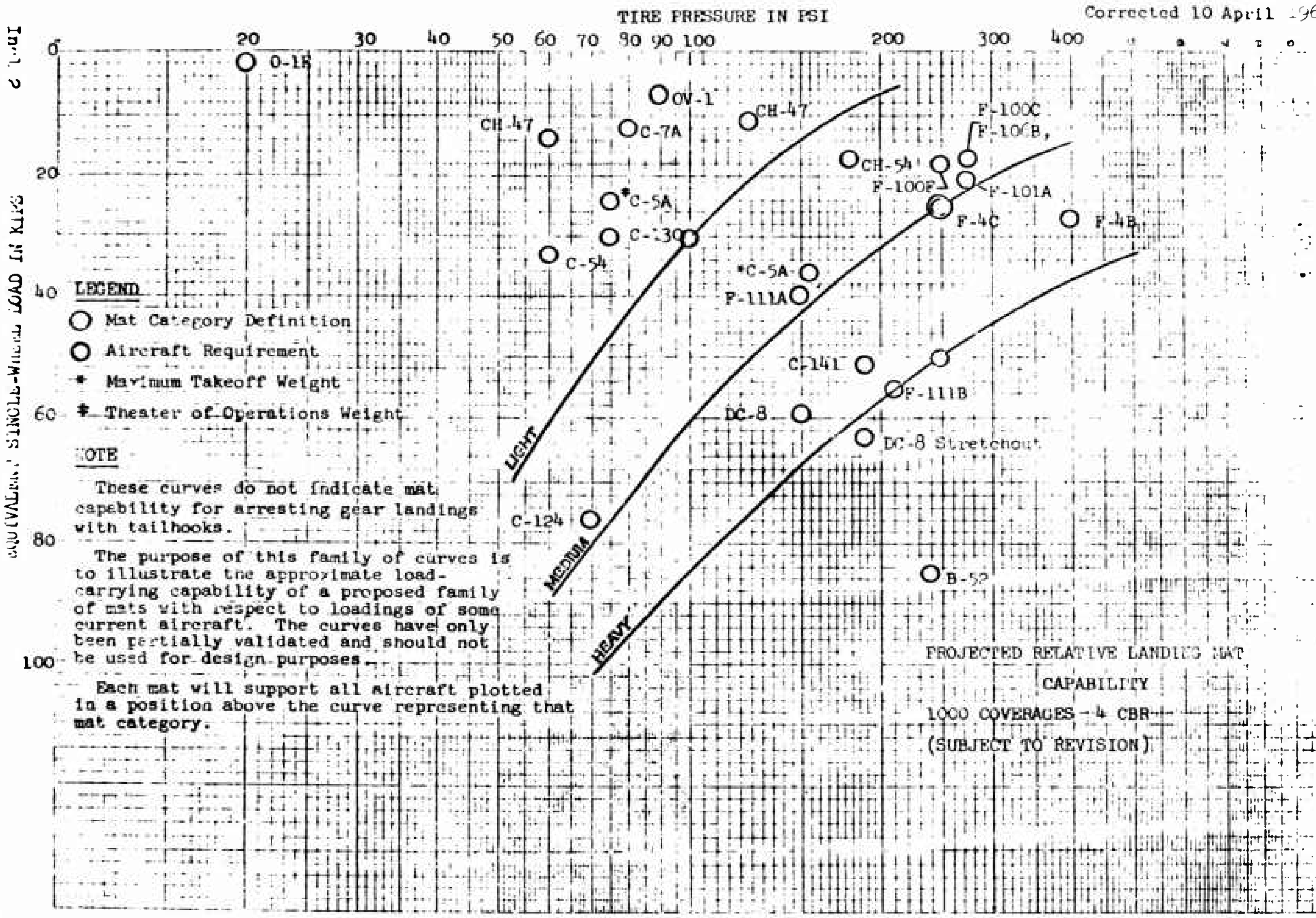
Table 4

Membrane Classification	Desirable Weight lb per sq yd	Essential Weight lb per sq yd
Heavy duty	5.0	6.0
Medium duty	3.0	4.0
Light duty	1.0	2.0

Table 5

Membrane Classification	Desirable Placing Rate sq ft per man-hour	Essential Placing Rate sq ft per man-hour
Heavy duty	300	200
Medium duty	400	300
Light duty	600	400

Incl 1



PROJECTED RELATIVE LANDING MAT CAPABILITY

1000 COVERAGES - 4 CBR

(SUBJECT TO REVISION)

Incl 2

A-19

PROJECTED PERFORMANCE OF MEMBRANES FOR PERIOD OF SIX MONTHS (1200 SORTIES*)

(This is a preliminary table subject to revision)

Aircraft	Operation: Landing	Operation: Max Engine Run-Up for Takeoff	Operation: Locked-Wheel Turns	Operation: Taxiing	Operation: Locked-Wheel Braking	Auxiliary Use: Waterproofing Beneath Landing Mats
Heavy-Duty Membrane (5-6 lb per sq yd)						
F-111A	4	4	4	4	4	4
F-111B	4	4	4	4	4	4
F-4B	4	4	4	4	4	1
C-141	4	4	4	4	4	1
C-5	4	4	4	4	4	4
C-130E	1	1	1	1	1	1
C-7A	1	1	1	1	1	1
CH-54	1	1	1	1	1	1
CH-47	1	1	1	1	1	1
UH-1	1	1	NA	1	NA	1
OV-1	1	1	1	1	1	1
O1-E	1	1	1	1	1	1
Medium-Duty Membrane (3-4 lb per sq yd)						
F-111A	4	4	4	4	4	4
F-111B	4	4	4	4	4	4
F-4B	3	3	1	4	4	1
C-141	4	4	4	4	4	4
C-5	4	4	4	4	4	4
C-130E	2	2	1	1	1	1
C-7A	1	1	1	1	1	1
CH-54	1	1	1	1	1	1
CH-47	1	1	1	1	1	1
UH-1	1	1	NA	1	NA	1
OV-1	1	1	1	1	1	1
O1-E	1	1	1	1	1	1
Light-Duty Membrane (1-2 lb per sq yd)						
F-111A	4	4	4	4	4	4
F-111B	4	4	4	4	4	4
F-4B	4	4	3	1	3	1
C-141	4	4	4	4	4	4
C-5	4	4	4	4	4	4
C-130E	3	3	2	1	2	1
C-7A	3	3	2	1	2	1
CH-54	1	1	1	1	1	1
CH-47	1	1	1	1	1	1
UH-1	3	3	NA	3	NA	1
OV-1	3	3	3	1	1	1
O1-E	1	1	1	1	1	1

Remarks

Performance rating scale for membranes:

1 Satisfactory
2 Borderline
3 Unsatisfactory
4 No test data available

* Sortie - one landing and one takeoff

NOTE: The purpose of this projected performance of a family of membranes is to indicate their relative capabilities for selected current aircraft and helicopters.

Incl 3

APPENDIX B

COMPUTER PROGRAMS

```
// FOR
*IOCS(CARD,TYPEWRITER)
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
*TRANSFER TRACE
C  READ IN DATA AND CALCULATE MINIMUM MEMBRANE STRENGTHS REQUIRED
C
       REAL NL(17),LC(17,4),LR(17),LT(17),MHQ
C
       COMMON NAFPC(17),NAME(3),NAP(17),LIFE(17),PRQ(3),WTQ(3),WTE(17,4),
      1 WTC(17,4),WTT(17,4),SNE(17,4),SNC(17,4),SNT(17,4),A(17,5)
       COMMON V1,V2,T1,T2,AQ,SP,PB,SLQ,C,CN,S,SPP DTQ,TT,WFACT,VFACT,
      1 DFACT,AFACT,CW,RVC,NAFL,NAFN,IS,I,NL,LC,LR,LT,MHQ
       COMMON TLONG,TWIDE,ELEV,TEMP,WD(17,4),WOA(17,4)
C
2      FORMAT(I2,30X,5F6.0)
3      FORMAT(2X,26I3)
5      FORMAT(5F6.0)
7      FORMAT(I2,5X,10F5.0)
8      FORMAT(3A2,2F3.0,2F4.0,F3.0,I3,F3.0,F4.0,F5.0,F3.0,F2.0,F2.0,3F4.0
      1 ,3F2.0)
22     FORMAT('SENSE  T A S'2X   'NSE'3X'NSC'3X'NST'3X'WTE'2X'WTC'2X'WTT'
      1 2X 'WOA'    3X'MSE'3X'MSC'3X'MST'2X'AV'3X'DT'4X'MMM'3X'SC'4X'P',
      2 5X'SLE'5X'SLC'5X'SLT'//)
C
       KSW1=1
100    CALL DATSW(14,ISW14)
       GO TO (105,101),ISW14
101    PAUSE 1111
       KSW1=1
105    KSW2=1
C
C READ WEIGHT, VOL, DENSITY, AND AREA FACTORS
       CALL DATSW(1,ISW1)
       GO TO (110,140),ISW1
110    KSW2=2
       READ(2,5)WFACT,VFACT,DFACT,AFACT,CW
 C
C READ PARAMETER CARD
140    CALL DATSW(2,ISW2)
       GO TO (150,160),ISW2
150    READ(2,8)NAME,V1,V2,T1,T2,AQ,IS,PB,MHQ,SLQ,SP,C,CN,(PRQ(N),N=1,3),
      2(WTQ(N),N=1,3)
       S=IS
       SPP=(SP+1.)/2000.
       V1=V1*5280.
       V2=V2*5280.
       DTQ=24.*(1.-AQ/100.)/S
       TT=T1+T2/(C*CN)
       RVC=1./(V1*CN)
C
C READ IN THEATER DATA
160    CALL DATSW(3,ISW3)
       GO TO (165,175),ISW3
165    READ(2,2)I,TLONG,TWIDE,ELEV,TEMP
       IF( I )111,111,115
111    CALL STACK
       GO TO 165
115    KSW2=2
       READ(2,3)  (NAFPC(J),J=1,17)
C
C
C
```

```
C
C
C
C READ IN AIRFIELD DATA
175    CALL DATSW(4,ISW4)
       GO TO (180,185),ISW4
180    READ(2,3)NAC,NAFL,NAFU
       IF(NAC)166,166,167
166    CALL STACK
       GO TO 180
167    KSW2=2
       DO 170 K=1,NAC
       READ(2,7) N,NL(N), (LG(N,J),WD(N,J),J=1,4)
170    CONTINUE
C
C CALCULATE AIRFIELD DATA
185    GO TO (250,190),KSW2
190    CALL AFDAT
C
C DO SENSITIVITY ANALYSIS OR GET MINIMUM MEMBRANE REQUIREMENTS
250    CALL DATSW(5,ISW5)
       GO TO (255,350),ISW5
255    GO TO (275,300),KSW1
275    WRITE(1,22)
       KSW1=2
300    CALL CAL1
C
350    GO TO 100
       END

FEATURES SUPPORTED
 TRANSFER TRACE
 ONE WORD INTEGERS
 IOCS

CORE REQUIREMENTS FOR
 COMMON    1616  VARIABLES     14  PROGRAM    506

 END OF COMPILATION
```

```
// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE AFDAT
C
      REAL NL(17),LG(17,4),LR(17),LT(17),MHO,LGTAX
C
      COMMON NAFPC(17),NAME(3),NAP(17),LIFE(17),PRO(3),WTQ(3),WTE(17,4),
     1 WTC(17,4),WTT(17,4),SHE(17,4),SHC(17,4),SHT(17,4),A(17,5)
      COMMON V1,V2,T1,T2,AO,SP,PR,SLQ,C,CN,S,SPP,DTQ,TT,WFACT,VFACT,
     1 DFACT,AFACT,CW,RVC,NAFL,NAFU,IS,I,NL,LG,LR,LT,MHO
      COMMON TLONG,TWIDE,ELEV,TEMP,WD(17,4),WOA(17,4)
C
      DEE=0.
      DET=0.
      DELT=TEMP-59.0
      IF(DELT)190,190,185
185   DET=DELT/300.
190   DELE=ELEV-1000.
      IF(DELE)200,200,195
195   DEE=DELE/10000.
200   ADJST=(1.+DET)*(1.+DEE)
      DO 220 J=NAFL,NAFU
      IF( NAFPC(J) )215,215,210
210   IF(J-17)211,212,212
211   LR(J)=LG(J,1)*ADJST
      LGTAX=LG(J,2)*ADJST
      LT(J)   = LGTAX +LG(J,3)+LG(J,4)+WD(J,4)*2.
      A(J,3)   =( LGTAX *WD(J,2)+LG(J,3)*WD(J,3)+LG(J,4)*WD(J,4))*AFACT
      A(J,4)   =LR(J)   *WD(J,1)*AFACT
      GO TO 216
212   LR(J)=LG(J,1)*6
      LT(J)=WD(J,1)*3.
      A(J,3)=LG(J,1)*WD(J,1)*AFACT*2.
      A(J,4)=0.
      GO TO 216
215   A(J,4)=0.
      A(J,3)=0.
      LR(J)=0.
216   A(J,1)=A(J,4)/3.
      A(J,2)=A(J,1)*2.
      A(J,5)=A(J,4)+A(J,3)
220   CONTINUE
      RETURN
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR AFDAT
 COMMON    1616  VARIABLES     22  PROGRAM    334

 END OF COMPILATION
```

```
// FOR
*ONE WORD INTEGERS
* LIST SOURCE PROGRAM
C
      SUBROUTINE CAL1
C
C CALCULATE MINIMUM STRENGTH AND WEIGHT TO MEET QMR AV, MMH, AND SL.
C
      REAL NL(17),LG(17,4),LR(17),LT(17),MHQ,MMH,MSE,MSC,MST,MSBDT,MSBDR
C
      COMMON NAFPC(17),NAME(3),NAP(17),LIFE(17),PRQ(3),WTQ(3),WTE(17,4),
     1 WTC(17,4),WTT(17,4),SWE(17,4),SWC(17,4),SWT(17,4),A(17,5)
      COMMON V1,V2,T1,T2,AC,SP,PB,SLQ,C,CN,S,SPP,DTQ,TT,WFACT,VFACT,
     1 DFACT,AFACT,CW,RVC,NAFL,NAFU,IS,I,NL,LG,LR,LT,MHQ
      COMMON TLONG,TWIDE,ELEV,TEMP,WD(17,4),WOA(17,4)
C
20    FORMAT(3A2,2I2,2X'TILT'I2)
21    FORMAT(3A2,3I2,3F6.0,4F5.0,  3F6.0,F5.1,2F6.3,F5.1,F5.2,3F8.0)
22    FORMAT(2I2,4X,6E12.5)
23    FORMAT(4I2,5F12.5)
24    FORMAT(2I2 4X,5E12.5,2F6.0)
C
      BAR(XX,YY)=1./(1./XX+1./YY)
C
      CALL DATSW(10,ISW10)
      GO TO (80,85),ISW10
80    WRITE(2,22)
      N1=1
      N2=2
      N3=3
      N4=4
85    R3=1./3.
      CCN=C*CN
      CWW=SPP/CW
      XLOG=-ALOG(PB)
      VAL3=55.*SLQ/SP
C
C  DO EACH AIRFIELD
      DO 700 J=NAFL,NAFU
      IF(NAFPC(J)  )700,700,50
50    T3=LT(J)  /V2
      VAL1=LR(J)*RVC
      VAL2=LT(J)*RVC
      KASE=1
      IF((J-3)*(J-7))55,52,55
52    KASE=2
      GO TO 65
55    IF(J-17)65,60,60
60    KASE=3
C
C  RUNWAY REQUIREMENTS
65    I01=IFIX(VAL1/DTQ+1.)
      I02=IFIX((T3+VAL1)*CCN/MHQ+1.)
      IF(I02-I01)105,105,100
100   I01=I02
105   IF(I01-IS)115,115,110
110   NOGO=1
      GO TO 999
115   DO 120 KK=I01,IS
      S0=IS-KK+I01
C
C
C
```

```
C
C
C
      TEST=S0/XLOG
      MSBDR=TT/(DTQ-VAL1/S0)
      IF(MSBDR-TEST)120,130,130
120   CONTINUE
      IF(I01-1)130,130,125
125   MSBDR=TEST
130   GO TO (133,305,305),KASE
C
C  TAXIWAY REQUIREMENTS
133   TEM =(T3+VAL1)/S0
         I11 =  IFIX(VAL2/(MHQ/CON-TEM )+1.)
      IF(I11-IS)140,140,135
135   NOGO=2
      GO TO 999
140   DO 155 KK=I11,IS
      S1=IS-KK+I11
      CON=MHQ-TEM*CON-VAL2*CON/S1
      TEST=T2*73./72./CON
      IF(TEST-MSBDR)145,150,150
145   TEST=MSBDR
150   MSBDT=T2/(CON-T2/TEST)
      TES=S1/XLOG
      IF(MSBDT-TES)155,165,165
155   CONTINUE
      IF(I11-1)165,165,160
160   MSBDT=TES
165   MSBDR=TEST
      TEST=MSBDT/72.
      IF(MSBDR-TEST)220,225,225
220   MSBDR=TEST
225   IF(S0+1.-S)227,227,235
227   P0=EXP(-(S0+1.)/MSBDR)
      IF(P0-PB)235,230,230
230   S0=S0+1.
      GO TO 133
C
C CONSIDER ONE, TWO AND THREE MEMBRANE SYSTEM
C
235   KU=3
      GO TO 306
305   KU=1
306   DO 600 K=1,KU
C
C SERVICE LIFE REQUIREMENTS
      SBDR=MSBDR
      SBDT=MSBDT
      GO TO (310,325,395),K
C
C ONE MEMBRANE ON ENTIRE AIRFIELD
310   GO TO (310,311,314),KASE
311   TEST=((VAL3/A(J,5))**3*34./9.)**0.25
      IF(SBDR-TEST)312,313,313
312   SBDR=TEST
313   SBDT=0.
      SBDE=SBDR*3./8.
      SBDC=SBDR*9.
      SBDO=SBDR
      GO TO 431
314   TEST=((VAL3/A(J,5))**3*272.)**0.25
      IF(SBDR-TEST)315,316,316
C
C
C
```

```
C
C
C
315    SBDR=TEST
316    SBDE=0.
       SBDC=0.
       SBDT=SBDR
       SBDO=SBDR
       CONT=(SBDT/272.)**R3
       CONE=0.
       CONC=0.
       GO TO 435
318    TEST=((VAL3 / A(J,5))**3*272./73.)**0.25
       TEM =TEST*73./72.
       IF(SBDR-TEM )319,320,320
319    SBDR=TEM
320    SBDT=SBDR*72.
       GO TO 345
C
C TWO MEMBRANES, ONE ON RUNWAY
325    TEST=((VAL3 / A(J,4))**3*34./9.)**0.25
       IF(SBDR-TEST)330,335,335
330    SBDR=TEST
335    TEST=((VAL3 / A(J,3))**3*272.)**0.25
       IF(SBDT-TEST)340,345,345
340    SBDT=TEST
       TEST=SBDT/72.
       IF(SBDR-TEST)341,345,345
341    SBDR=TEST
345    SBDE=SBDR*9./8.
       SBDC=SBDR*9.
       GO TO 430
C
C THREE MEMBRANES, ENDS, CENTERS, OTHER
395    TEST=((VAL3 / A(J,3))**3*272.)**0.25
       IF(SBDT-TEST)400,410,410
400    SBDT=TEST
       TEST=SBDT/72.
       IF(SBDR-TEST)405,410,410
405    SBDR=TEST
410    SBDC=SBDR*2.
       TEST=SBDT/8.
       IF(SBDC-TEST)415,420,420
415    SBDC=TEST
420    TEST=((VAL3 / A(J,2))**3*34.)**0.25
       IF(SBDC-TEST)421,423,423
421    SBDC=TEST
       TEST=SBDC/9.
       IF(SBDR-TEST)422,423,423
422    SBDR=TEST
423    SBDE=BAR(SBDR,-SBDC)
       TEST=((VAL3 / A(J,1))**3*4.25)**0.25
       IF(SBDE-TEST)425,430,430
425    SBDE=TEST
       SBDR=BAR(SBDE,SBDC)
430     SBDO=BAR( SBDR, SBDT)
C
C  COMPUTE STRENGTH REQUIREMENTS
431    CONE=(SBDE/4.25)**R3
       CONC=(SBDC/34.0)**R3
       CONT=(SBDT/272.)**R3
435    NSE=CONE*NL(J)
       NSC=CONC*NL(J)
C
C
C
```

```
C
C
C
      NST=CONT*NL(J)
C
C GET WEIGHTS (IN TONS)
      WTE(J,K)=A(J,1)*NSE*CWW
      WTC(J,K)=A(J,2)*NSC*CWW
      WTT(J,K)=A(J,3)*NST*CWW
      SNE(J,K)=NSE
      SNC(J,K)=NSC
      SNT(J,K)=NST
      WOA(J,K)=WTE(J,K)+WTC(J,K)+WTT(J,K)
C
C COMPUTE FINAL PERFORMANCE VALUES FOR PRINTOUT
      DT=VAL1/S0+TT/ SBDR
      GO TO (497,496,496),KASE
496   MMH= (T3+VAL1)*CCN/S0+T2/SBDO
      P1=0.
      GO TO 498
497   MMH=(T3/S0+VAL1/S0+VAL2/S1+T2/CCN/ SBDO)*CCN
      P1=EXP(-S1/ SBDT)
498   P0=EXP(-S0/ SBDR)
      AV=(1.-S*DT/24.)*100.
      GO TO (502,504,508),K
502   GO TO(503,505,506),KASE
503   SLE=272./73. * A(J,5)*SP*CONE**4/55.
      SLC=SLE
      SLT=SLE
      GO TO 509
504   SLE=34.0/9.0 * A(J,4)*SP*CONE**4/55.
      SLC=SLE
      SLT=  272.   *  A(J,3)*SP*CONT**4/55.
      GO TO 509
505   SLE=34.0/9.0*A(J,4)*SP*CONE**4/55.
      SLC=SLE
      SLT=0.
      GO TO 509
506   SLT=272.*A(J,5)*SP*CONT**4/55.
      SLC=0.
      SLE=0.
      GO TO 509
508   SLE=  4.25   *  A(J,1)*SP*CONE**4/55.
      SLC=  34.0   *  A(J,2)*SP*CONC**4/55.
      SLT=  272.   *  A(J,3)*SP*CONT**4/55.
509   WRITE(1,21)NAME,I,J,K,SNE(J,K),SNC(J,K),SNT(J,K),WTE(J,K),WTC(J,K)
     1,WTT(J,K),WOA(J,K),SBDE,SBDC,SBDT,AV,DT,MMH,S0,P0,SLE,SLC,SLT
      CALL DATSW(10,ISW10)
      GO TO (520,590),ISW10
520   WRITE(2,23)I,J,K,N1,SNE(J,K),SNC(J,K),SNT(J,K),WTE(J,K),WTC(J,K),
     1 WTT(J,K),I,J,K,N2,WOA(J,K),SBDO,SBDR,SBDE,SBDC,SBDT,
     2 I,J,K,N3,AV,DT,MMH,SLE,SLC,SLT,I,J,K,N4,S0,P0,S1,P1
590   CALL DATSW(0,ISW0)
      GO TO (900,600),ISW0
600   CONTINUE
C
C SAVE SCHEME WITH MINIMUM WEIGHT
      WMIN=WOA(J,1)
      KSV=1
      GO TO (605,670,670),KASE
605   DO 615 K=2,3
      IF(WOA(J,K) - WMIN)610,615,615
610   WMIN=WOA(J,K)
C
C
C
```

```
C
C
C
      KSV=K
615   CONTINUE
670   CALL DATSW(10,ISW10)
      GO TO (680,690),ISW10
680   WRITE(2,22)I,J,SNE(J,KSV),SNC(J,KSV),SNT(J,KSV),WTE(J,KSV),
     1 WTC(J,KSV),WTT(J,KSV)
      WRITE(2,24)I,J,(A(J,K),K=1,5),LR(J),LT(J)
      GO TO 690
999   WRITE(1,20)NAME,I,J,NOGO
690   WRITE(1,21)
      WRITE(1,21)
C
      CALL DATSW(0,ISW0)
      GO TO (900,700),ISW0
700   CONTINUE
C
900   RETURN
C
      END
```

FEATURES SUPPORTED
ONE WORD INTEGERS

CORE REQUIREMENTS FOR CAL1
COMMON 1616 VARIABLES 100 PROGRAM 1352

END OF COMPILATION

```
// FOR
*IOCS(CARD,TYPEWRITER)
*ONE WORD INTEGERS
* LIST SOURCE PROGRAM
C
C   CLASS MEMBRANE STRENGTHS AND ASSIGN TO AIRFIELDS
C
      DIMENSION WTS(5,17,3),STS(5,17,3),TAB(250,2), A(5,17,5),NSW(3),
     1 TON(5,17),NAFPC(5,17),NSV(3,3),SAVE(3)
C
1     FORMAT(4I3,3F4.0)
4     FORMAT(1X'NC'3X'NS'4X'WT'/)
5     FORMAT(I3,F6.0,F7.3)
12    FORMAT(I2,26I3)
14    FORMAT(////2X'T'2X'A'4X'E'4X'C'4X'T'5X'E'6X'C'6X'T'/)
15    FORMAT(2I3,3I5,3F7.0)
16    FORMAT(////3X'S'3X'T'3X'A'3X'E'3X'C'3X'T'6X'TONS'/)
17    FORMAT(///'L    1    2    3       TONS'/)
18    FORMAT(I1,3I4,F10.0)
19    FORMAT(6I4,F10.0)
20    FORMAT(2I4,16X,F10.0)
21    FORMAT(I4,20X,F10.0)
22    FORMAT(2I2,4X,6E12.5)
C
C     ZERO OUT ARRAYS
      DO 25 I=1,5
      DO 25 J=1,17
      DO 24 K=1,3
      WTS(I,J,K)=0
      STS(I,J,K)=0
24    CONTINUE
      DO 25 K=1,5
      A(I,J,K)=0
25    CONTINUE
C
C     READ HEADER CARDS
      READ(2,1)NTHL,NTHU,NAFL,NAFU,SP,WFACT,CW
      FACT=(1.+SP+WFACT)/2000.
C
C     READ DATA CARDS
      READ(2,1)NCD
      DO 40 KK=1,NCD
      READ(2,22)I,J,(STS(I,J,K),K=1,3)
      READ(2,22)I,J,(A(I,J,K),K=1,5)
40    CONTINUE
      DO 42 K=NTHL,NTHU
      READ(2,12)I,(NAFPC(I,J),J=1,17)
42    CONTINUE
      WRITE(2,5)
C
C     FIND  MAX AND MIN STRENGTH
      SMIN=0.1E30
      SMAX=0
      DO 91 I=NTHL,NTHU
      DO 91 J=NAFL,NAFU
      IF(NAFPC(I,J)*(J-1)*(J-2)*(J-14)*(J-15)*(J-16)) 75, 91, 75
75    IF(J-17)77,76,76
 76   KL=3
      GO TO 78
77    KL=1
C
C
```

```
C
C
C
C
70    DO 90 K=KL,3
      IF(STS(I,J,K)-SMAX)85,85,80
80    SMAX=STS(I,J,K)
85    IF(STS(I,J,K)-SMIN)87,90,90
87    SMIN=STS(I,J,K)
90    CONTINUE
91    CONTINUE
C
C     DIVIDE INTO CLASSES SO THAT SMAX(I)=SMAX*0.9**(I-1)
      MM=ALOG(SMIN/SMAX)/ALOG(.9)+1
      DO 100 N=1,MM
      L=MM+1-N
      TAB(N,1)=SMAX*.9**(L-1)
C     GET MIN MEMBRANE WEIGHT TO GIVE REQD STRENGTH
      TAB(N,2)=TAB(N,1)/CW
100   CONTINUE
C
C     LIST CLASSES
      WRITE(1,4)
      WRITE(2,5)(N,(TAB(N,J),J=1,2),N=1,MM)
      WRITE(1,5)(N,(TAB(N,J),J=1,2),N=1,MM)
      WRITE(1,14)
C
C     REDEFINE STRENGTHS AND WEIGHTS IN TERMS OF CLASS MAX
      DO 160 I=NTHL,NTHU
      DO 159 J=NAFL,NAFU
      IF(NAFPC(I,J)*(J-1)*(J-2)*(J-14)*(J-15)*(J-16))120,159,120
120   IF(J-17)122,121,121
121   KL=3
      NSW(1)=0
      NSW(2)=0
      GO TO 123
122   KL=1
123   DO 142 K=KL,3
      DO 140 L=1,MM
      IF(STS(I,J,K)-TAB(L,1))150,150,140
140   CONTINUE
      L=MM
150   STS(I,J,K)=TAB(L,1)
      WTS(I,J,K)=TAB(L,2)
      NSW(K)=L
142   CONTINUE
      DO 151 N=1,3
151   WTS(I,J,N)=WTS(I,J,N)*A(I,J,N)*FACT
      WRITE(1,15)I,J,NSW,(WTS(I,J,K),K=1,3)
      WRITE(2,15)I,J,NSW,(WTS(I,J,K),K=1,3)
159   CONTINUE
      WRITE(1,15)
160   CONTINUE
C
C  SUMMARIZE TONNAGE FOR 1, 2, OR 3-MEMBRANE SYSTEM
      WRITE(1,17)
      K2L=1
      K2U=1
      K3L=1
      K3U=1
      DO 231 L=1,3
      SAVE(L)=0.1E38
      GO TO (170,155,155),L
155   K2U=MM-1
C
C
```

```
C
C
C
C
      GO TO (170,170,165),L
165   K2L=2
170   DO 230 K2=K2L,K2U
      GO TO (180,180,175),L
175   K3U=K2-1
180   DO 230 K3=K3L,K3U
      WOA=0.
      DO 250 I=NTHL,NTHU
      DO 250 J=NAFL,NAFU
      IF(NAFPC(I,J)*(J-1)*(J-2)*(J-14)*(J-15)*(J-16))181,250,181
181   IF(J-17)183,182,182
182   KL=3
      GO TO 184
183   KL=1
184   TON(I,J)=0.
      DO 220 K=KL,3
      GO TO (210,200,190),L
190   IF(STS(I,J,K)-TAB(K3,1))195,195,200
195   TON(I,J)=TON(I,J)+TAB(K3,2)*A(I,J,K)*FACT
      GO TO 220
200   IF(STS(I,J,K)-TAB(K2,1))205,205,210
205   TON(I,J)=TON(I,J)+TAB(K2,2)*A(I,J,K)*FACT
      GO TO 220
210   TON(I,J)=TON(I,J)+TAB(MM,2)*A(I,J,K)*FACT
220   CONTINUE
      WOA=WOA+TON(I,J)*NAFPC(I,J)
250   CONTINUE
      IF(WOA-SAVE(L))251,230,230
251   SAVE(L)=WOA
      NSV(L,1)=K3
      NSV(L,2)=K2
230   CONTINUE
      NSV(L,3)=MM
      GO TO (232,234,236),L
232   K3=0
      K2=0
      GO TO 237
234   K3=0
      K2=NSV(L,2)
      GO TO 237
236   K3=NSV(L,1)
      K2=NSV(L,2)
237   WRITE(1,18)L,K3,K2,MM,SAVE(L)
231   CONTINUE
C
C  GET ACTUAL USAGE OF EACH SYSTEM AT EACH AIRFIELD
      WRITE(1,16)
      DO 286 L=1,3
      WOA=0.
      DO 284 I=NTHL,NTHU
      W1=0.
      DO 282 J=NAFL,NAFU
      IF(NAFPC(I,J)*(J-1)*(J-2)*(J-14)*(J-15)*(J-16))265,282,265
265   IF(J-17)268,266,266
266   KL=3
      NSW(1)=0
      NSW(2)=0
      GO TO 269
268   KL=1
269   TON(I,J)=0.
C
C
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```
C
C
C
C
      DO 280 K=KL,3
      GO TO (278,274,270),L
270   K3=NSV(L,1)
      IF(STS(I,J,K)-TAB(K3,1))272,272,274
272   NSW(K)=K3
      TON(I,J)=TON(I,J)+TAB(K3,2)*A(I,J,K)*FACT
      GO TO 280
274   K2=NSV(L,2)
      IF(STS(I,J,K)-TAB(K2,1))276,276,278
276   NSW(K)=K2
      TON(I,J)=TON(I,J)+TAB(K2,2)*A(I,J,K)*FACT
      GO TO 280
278   TON(I,J)=TON(I,J)+TAB(MM,2)*A(I,J,K)*FACT
      NSW(K)= MM
280   CONTINUE
      WRITE(1,19)L,I,J,NSW,TON(I,J)
      W1=W1+TON(I,J)
282   CONTINUE
      WOA=WOA+W1
      WRITE(1,20)L,I,W1
      WRITE(1,15)
284   CONTINUE
      WRITE(1,21)L,WOA
      WRITE(1,15)
      WRITE(1,15)
286   CONTINUE
C
      CALL EXIT
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS
 IOCS

CORE REQUIREMENTS FOR
 COMMON       0  VARIABLES    3192  PROGRAM   2040

 END OF COMPILATION
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```
// FOR
*IOCS(CARD,DISK,TYPEWRITER)
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
C   PROGRAM TO COMPUTE COST EFFECTIVENESS OF MEMBRANES
C
       REAL MSBDE,MSBDC,MSBDT,MSBDR,MSBDO
C
       DIMENSION A(5),XNL(17),NAFPC(17),NAME(3),STR(25),SUM1(17),SUM2(17)
      1,LIFE(17),PRQ(3),WTQ(3),VAL(10)
C
       COMMON      K,KE,KC,KT,MSE,MSC,MST,SS,SLE,SLC,SLT,SL,PRE,PRC,PRT,
      1 PRS,RA,RS,RP,EF,TS,XMH,AV,DT,S0,P0,S1,P1,PRE0,PRC0,PRT0,PRS0,XNL,
      2WTE,WTC,WTT,A,A1,A2,A3,AL,AM,AH,TONL,TONM,TONH,TONE,TONC,TONT,TON,
      3CI,CIR,CSOCA,CSOCS,CSCCA,CSCCS,CSCFA,CSCFS,CSTA,CSTS,CP,RMH,CR,T3,
      4 CSAB,CSSB,CSACR,CSSCR,CFA,CFS,CM,CTA,CTS,CEA,CES,CEO, RL,TL,VAL1,
      5 MSH,MSM,MSL,NOGO,SNE,SNC,SNT,MSBDE,MSBDC,MSBDT,MSBDR,MSBDO,VAL2
       COMMON R3,R23,S,DTQ,CCN,XLOG,RVC,TT,WF,DCFA,DCFS,KSW,NM,KASE,SPTS
       COMMON PMH,RRE,RRC,RRT,STR,LIFE,       WFACT,RFACT,CW,WA,WS,WP
       COMMON    NAME,V1,V2,T1,T2,AQ,IS,PB,QMH,SLQ,SP,C,CN,PRQ,WTQ,PC
       COMMON    CFACT,COPS,COPA,CCFS,CCFA,CPMH,CPEH,CPEHI
       COMMON      NO,DOPA,DOPS,DCCA,DCCS,DCCSA,TLONG,CCCA,CCCS,NAFPC
C
       DEFINE FILE 1(17,17,U,NF1),2(17,17,U,NF2),3(17,17,U,NF3),
      1 4(17,17,U,NF4),5(17,17,U,NF5),6(5,34,U,NF6),7(85,160,U,NF7)
C
1      FORMAT(4I3,6F6.0)
2      FORMAT(3A2,2F3.0,2F4.0,F3.0,I3,F3.0,F4.0,F5.0,F3.0,F2.0,F2.0,3F4.0
      1 ,3F2.0,F3.0)
3      FORMAT(2X,I2,2F8.0)
4      FORMAT(10F8.0)
5      FORMAT(2X,26I3)
6      FORMAT(I2,12X,4F6.0,24X,2F6.0)
7      FORMAT(8X,5E12.5,2F6.0)
8      FORMAT(2X,I5,F5.0)
9      FORMAT(5X,F6.0)
10    0FORMAT(////'SYSTEM'I2' -'I2,3X'LIGHT='I2,2X'MEDIUM='I2,2X'HEAVY='
10    1 I2,4X'ORIGIN='I2,4X'CASE='I2,4X'PARAMETERS - '3A2)
11     FORMAT(I1,I3,3F9.0, 6F7.0,    2F8.0,   2F7.1,   2F8.0)
13     FORMAT(I1,I3,3I4,2F7.1,F10.0,4F7.0,1X,4F8.2)
14     FORMAT(I1' TOT'F8.0,2F9.0,6F7.0,2F8.0,2F7.1,2F8.0/)
15     FORMAT('TOTAL'F8.0,2F9.0, 6F7.0,   2F8.0,   2F7.1,   2F8.0)
16     FORMAT(I1,I3,F6.0,F7.0,2F8.0,2F7.0,2F7.1,F9.0,F8.0,2F6.0,F6.3,
16    1 4F6.0)
17     FORMAT(I1' TOT'4X,3F8.0,2F7.0,2F7.1,F9.0,F8.0,2F6.0,F6.3,4F6.0/)
18     FORMAT('TOTAL' 4X,3F8.0,2F7.0,2F7.1,F9.0,F8.0,2F6.0,F6.3,4F6.0/)
600   0FORMAT(  //9X,'CLASS'5X'AVAILABILITY'4X'S.L.' 10X'PLACEMENT RATE'
600   1 14X'NORMALIZED'/'T'2X'A'3X'E'3X'C'3X'T'4X'0/0'1X'SORTIES'2X'SORTI
600   2ES'5X'E'6X'C'6X'T'2X'SORTIES'3X'AVAIL'4X'S.L.'3X'P.R.'3X'EFFECT.'
600   3/)
601    FORMAT(2I3,3I5)
602   0FORMAT(  //12X'AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES' 5X
602   1'T R A N S P O R T A T I O N   C O S T S   ( $ 1 0 0 0 )'/
602   2 10X'AREA (1000 SQ FT)'12X'WEIGHT (TONS)'9X 'ORIGIN-PORT' 5X'CONUS
602   3-COMMZ' 4X'COMMZ-FIELD'5X'TOTAL'/'T'2X'A'3X'LIGHT'3X'MEDIUM'4X
602   4 'HEAVY'3X'LIGHT' 1X'MEDIUM'1X'HEAVY'2X'TOTAL'3X'AIR'3X'TRUCK' 5X
602   5 'AIR'4X'SHIP'4X'AIR'3X'TRUCK' 3X'AIR'3X'SURFACE'/)
603   0FORMAT(//12X,14('- '),'SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD
603   1 ($ 1000)',14(' -')/5X,'SORT-'11X'ORIGIN-FIELD'3X'EM-'4X'RE-'4X
603   2'FIELD-COMMZ'2X'RECOVERED VALUE'4X'FIXED'13X'TOTAL'5X'COST-EFF.')
C
C
C
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C
C
C
604   0FORMAT('T'2X'A'1X' IES '1X'INITIAL'3X'AIR'4X'SURF.'2X'PLACE'2X
604   1'COVER'3X'AIR'3X'SURF.'4X'AIR'5X'SURF.'2X'AIR'2X'SURF.'1X'MAINT.'
604   21X'AIR'2X'SURF.'2X'AIR'2X'SURF.'/)
C
      R3=1./3.
      R23=2./3.
C
1000  CALL DATSW(14,ISW14)
      NOGO=0
      GO TO (20,19),ISW14
19    PAUSE 1111
C
      CALL DATSW(0,ISW0)
      GO TO (1005,20),ISW0
1005  CALL EXIT
C
C  READ IN THEATER AND AIRFIELD NUMBERS, CONSTANTS, AND WEIGHTING FACTORS
20    CALL DATSW(1,ISW1)
      GO TO (21,22),ISW1
21    READ(2,1)NTHL,NTHU,NAFL,NAFU,WFACT,RFACT,CW,WA,WS,WP
      NOGO=5
C
C  READ PARAMETER CARD
22    CALL DATSW(2,ISW2)
      GO TO (23,26),ISW2
23    READ(2,2)NAME,V1,V2,T1,T2,AQ,IS,PB,QMH,SLQ,SP,C,CN,PRQ,WTQ,PC
      NOGO=5
C
      S=IS
      V1=V1*5280.
      V2=V2*5280.
      DTQ=24.*(1.-AQ/100.)/S
      CCN=C*CN
      XLOG=-ALOG(PB)
      RVC=1./(V1*CN)
      TT=T1+T2/CCN
C
C  READ COST DATA
26    CALL DATSW(4,ISW4)
      GO TO (27,28),ISW4
27    READ(2,4)CFACT,COPS,COPA,CCFS,CCFA,CPMH,CPEH,CPEHI
      NOGO=5
C
C  READ STRENGTH OF MEMBRANES IN TRIAL SYSTEM
28    CALL DATSW(5,ISW5)
      GO TO (29,30),ISW5
29    READ(2,5)NM,KASE,MSH,MSM,MSL
      NOGO=5
C
C  READ AND STORE THEATER DATA
      CALL DATSW(6,ISW6)
      GO TO (30,32),ISW6
30    DO 31 I=NTHL,NTHU
      READ(2,6)NT,DCCA,DCCS,DCCSA,TLONG,CCCA,CCCS
      READ(2,3)NO,DOPS,DOPA
      READ(2,5)NAFPC
      WRITE(6'NT)NO,DOPA,DOPS,DCCA,DCCS,DCCSA,TLONG,CCCA,CCCS,NAFPC
31    CONTINUE
      NOGO=5
C
C
C
C
```

```
C
C
C
C  READ AND STORE AIRFIELD AREAS AND MINIMUM STRENGTH REQUIRED
32     CALL DATSW(7,ISW7)
       GO TO (33,35),ISW7
33     READ(2,1)NAF,NUM
       DO 34 J=1,NAF
       READ(2,601)NT,NA,MSE,MSC,MST
       READ(2,7) A,RL,TL
       WRITE(NT'NA)MSE,MSC,MST,A,RL,TL
34     CONTINUE
       NOGO=5
C
C  READ CRITICAL AIRCRAFT APPLIED LOAD AND AIRFIELD LIFE
35     CALL DATSW(8,ISW8)
       GO TO (36,37),ISW8
36     READ(2,8)(LIFE(J),XNL(J),J=1,17)
       NOGO=5
C
C  READ STRENGTH CLASSES
37     CALL DATSW(9,ISW9)
       GO TO (38,40),ISW9
38     READ(2,1)NTAB
       READ(2,9)(STR(I),I=1,NTAB)
       NOGO=5
40     IF(NOGO-5)19,39,19
C
C  COMPUTE COST EFFECTIVENESS
39     WF=WFACT/2000.
       KSWW=1
       DO 450 I=NTHL,NTHU
       READ (6'I) NO,DOPA,DOPS,DCCA,DCCS,DCCSA,TLONG,CCCA,CCCS,NAFPC
       GO TO (700,702),KSWW
700    WRITE(1,10)NM,KASE,MSL,MSM,MSH,NO,NUM,NAME
       WRITE(1,600)
       LINE=10
       KSWW=2
702    KSW=1
       II=(I-1)*17
       DO 400 J=NAFL,NAFU
       IF(NAFPC(J)*(J-1)*(J-2)*(J-14)*(J-15)*(J-16))41,400,41
41     READ(I'J)MSE,MSC,MST,A,RL,TL
       T3=TL/V2
       VAL1=RL*RVC
       VAL2=TL*RVC
C
C  COMPUTE INTRA-THEATER SHIPPING DISTANCE
       IF(J-6)42,42,43
42     DCFA=TLONG*0.75
       DCFS=DCFA*1.25
       GO TO 50
43     IF(J-12)44,44,45
44     DCFA=TLONG*0.50
       DCFS=DCFA*1.25
       GO TO 50
45     IF(J-17)47,46,46
46     KSW=2
       GO TO 42
47     DCFA=TLONG*0.25
       DCFS=DCFA*1.25
C
50     CALL ISSUE
C
C
C
```

```
C
C
C
      CALL NSPEC(J)
C
      CALL EFECT(J)
C
      CALL COST
C
      NF=II+J
      WRITE(7'NF)K,KE,KC,KT,MSE,MSC,MST,SS,SLE,SLC,SLT,SL,PRE,PRC,PRT,
     1 PRS,RA,RS,RP,EF,TS,XMH,AV,DT,S0,P0,S1,P1,PREQ,PRCQ,PRTQ,PRSQ,
     2WTE,WTC,WTT,A,A1,A2,A3,AL,AM,AH,TONL,TONM,TONH,TONE,TONC,TONT,TON,
     3CI,CIR,CSOCA,CSOCS,CSCCA,CSCCS,CSCFA,CSCFS,CSTA,CSTS,CP,RMH,CR,
     4 CSAB,CSSB,CSACR,CSSCR,CFA,CFS,CM,CTA,CTS,CEA,CES,NAME,RL,TL
C
C  PRINT AVAILABILITY SERVICE LIFE, PLACEMENT RATE AND EFFECTIVENESS
      WRITE(1,13)I,J,MSE,MSC,MST,AV,SS,SL,PRE,PRC,PRT,PRS,RA,RS,RP,EF
      LINE=LINE+1
400   CONTINUE
      WRITE(1,1)
      LINE=LINE+1
450   CONTINUE
      LINE=66-LINE
      DO 460 L=1,LINE
460   WRITE(1,1)
      CALL DATSW(10,ISW10)
      GO TO (499,465),ISW10
C
C  PRINT AREA, WEIGHTS, SHIPPING COSTS
465   KSWW=1
      DO 475 L=1,15
      SUM1(L)=0.
475   CONTINUE
      DO 495 I=NTHL,NTHU
      READ (6'I) NO,DOPA,DOPS,DCCA,DCCS,DCCSA,TLONG,CCCA,CCCS,NAFPC
      GO TO (706,708),KSWW
706   WRITE(1,10)NM,KASE,MSL,MSM,MSH,NO,NUM,NAME
      WRITE(1,602)
      LINE=11
      KSWW=2
708   II=(I-1)*17
      DO 480 L=1,15
      SUM2(L)=0.
480   CONTINUE
      DO 490 J=NAFL,NAFU
      IF(NAFPC(J)*(J-1)*(J-2)*(J-14)*(J-15)*(J-16))485,490,485
485   NF=II+J
      READ (7'NF)K,KE,KC,KT,MSE,MSC,MST,SS,SLE,SLC,SLT,SL,PRE,PRC,PRT,
     1 PRS,RA,RS,RP,EF,TS,XMH,AV,DT,S0,P0,S1,P1,PREQ,PRCQ,PRTQ,PRSQ,
     2WTE,WTC,WTT,A,A1,A2,A3,(VAL(L),L=1,6),TONE,TONC,TONT,VAL(7),
     3CI,CIR, (VAL(L),L=8,15),CP,RMH,CR,
     4 CSAB,CSSB,CSACR,CSSCR,CFA,CFS,CM,CTA,CTS,CEA,CES,NAME,RL,TL
      DO 488 L=1,15
      IF(L-4)487,488,486
486   IF(L-7)488,488,487
487   VAL(L)=VAL(L)/1000.
488   CONTINUE
      WRITE(1,11)I,J,(VAL(L),L=1,15)
      LINE=LINE+1
      DO 489 L=1,15
489   SUM2(L)=SUM2(L)+VAL(L)*NAFPC(J)
490   CONTINUE
C
C
C
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C
C
C
      WRITE(1,14)I,(SUM2(L),L=1,15)
      LINE=LINE+2
      DO 493 L=1,15
      SUM1(L)=SUM1(L)+SUM2(L)
493   CONTINUE
495   CONTINUE
      WRITE(1,15) (SUM1(L),L=1,15)
      LINE=LINE+1
      LINE=60-LINE
      DO 498 L=1,LINE
498   WRITE(1,1)
C
C  PRINT COST SUMMARY
499   KSWW=1
      DO 500 L=1,17
      SUM1(L)=0.
500   CONTINUE
      DO 535 I=NTHL,NTHU
      READ (6'I) NO,DOPA,DOPS,DCCA,DCCS,DCCSA,TLONG,CCCA,CCCS,NAFPC
      GO TO (710,712),KSWW
710   WRITE(1,10)NM,KASE,MSL,MSM,MSH,NO,NUM,NAME
      WRITE(1,603)
      WRITE(1,604)
      LINE=11
      KSWW=2
712   II=(I-1)*17
      DO 510 L=1,17
      SUM2(L)=0.
510   CONTINUE
      DO 525 J=NAFL,NAFU
      IF(NAFPC(J)*(J-1)*(J-2)*(J-14)*(J-15)*(J-16))520,525,520
520   NF=II+J
      READ (7'NF)K,KE,KC,KT,MSE,MSC,MST,SS,SLE,SLC,SLT,SL,PRE,PRC,PRT,
     1 PRS,RA,RS,RP,EF,TS,XMH,AV,DT,S0,P0,S1,P1,PREQ,PRCQ,PRTQ,PRSQ,
     2WTE,WTC,WTT,A,A1,A2,A3,AL,AM,AH,TONL,TONM,TONH,TONE,TONC,TONT,TON,
     3VAL(1),CIR,CSOCA,CSOCS,CSCCA,CSCCS,CSCFA,CSCFS,(VAL(L),L=2,4),RMH,
     4 (VAL(L),L=5,16),NAME,RL,TL
      VAL(8)=VAL(8)+CIR
      VAL(9)=VAL(9)+CIR
      DO 523 L=1,16
523   VAL(L)=VAL(L)/1000.
      WRITE(1,16)I,J,TS,(VAL(L),L=1,16)
      LINE=LINE+1
      DO 524 L=1,16
524   SUM2(L)=SUM2(L)+VAL(L)*NAFPC(J)
      SUM2(17)=SUM2(17)+NAFPC(J)
525   CONTINUE
      DO 530 L=1,17
      SUM1(L)=SUM1(L)+SUM2(L)
530   CONTINUE
      DO 527 L=10,16
      SUM2(L)=SUM2(L)/SUM2(17)
527   CONTINUE
      WRITE(1,17)I,(SUM2(L),L=1,16)
      LINE=LINE+2
535   CONTINUE
      DO 541 L=10,16
      SUM1(L)=SUM1(L)/SUM1(17)
541   CONTINUE
      WRITE(1,18)(SUM1(L),L=1,16)
C
C
C
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C
C
C
      LINE=LINE+2
      LINE=66-LINE
      DO 540 L=1,LINE
540   WRITE(1,1)
C
      GO TO 1000
C
      END
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FEATURES SUPPORTED
 ONE WORD INTEGERS
 IOCS

CORE REQUIREMENTS FOR
 COMMON     424  VARIABLES     198  PROGRAM    3056

 END OF COMPILATION
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// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE ISSUE
C
C  MATCH AVAILABLE MEMBRANES WITH RUNWAY REQUIREMENTS
C   (ALSO GET QMR PLACEMENT RATES)
C
      REAL MSBDE,MSBDC,MSBDT,MSBDR,MSBDO
C
      DIMENSION A(5),XNL(17),NAFPC(17),NAME(3),STR(25),
     1 LIFE(17),PRQ(3),WTQ(3)
C
      COMMON      K,KE,KC,KT,MSE,MSC,MST,SS,SLE,SLC,SLT,SL,PRE,PRC,PRT,
     1 PRS,RA,RS,RP,EF,TS,XNN,AV,DT,S0,P0,S1,P1,PREQ,PRCQ,PRTQ,PRSQ,XNL,
     2WTE,WTC,WTT,A,A1,A2,A3,AL,AM,AH,TONL,TONM,TONH,TONE,TONC,TONT,TON,
     3CI,CIR,CSOCA,CSOCS,CSCCA,CSCCS,CSCFA,CSCFS,CSTA,CSTS,CP,RMH,CR,T3,
     4 CSAB,CSSB,CSACR,CSSCR,CFA,CFS,CM,CTA,CTS,CEA,CES,CEQ, RL,TL,VAL1,
     5 MSH,MSM,MSL,NOGO,SNE,SNC,SNT,MSBDE,MSBDC,MSBDT,MSBDR,MSBDO,VAL2
      COMMON R3,R23,S,DTQ,CCN,XLOG,RVC,TT,WF,DCFA,DCFS,KSW,MM,KASE,SPTS
      COMMON PMH,RRE,RRC,RRT,STR,LIFE,       WFACT,RFACT,CW,WA,WS,WP
      COMMON    NAME,V1,V2,T1,T2,AQ,IS,PB,QMH,SLO,SP,C,CN,PRQ,WTQ,PC
      COMMON    CFACT,COPS,COPA,CCFS,CCFA,CPMH,CPEH,CPEHI
      COMMON      NO,DOPA,DOPS,DCCA,DCCS,DCCSA,TLONG,CCCA,CCCS,NAFPC
C
      IF(MST-MSL)55,55,69
55    MST=MSL
      PRTQ=PRQ(3)
      KT=1
      IF(MSC-MSL)60,60,74
60    MSC=MSL
      PRCQ=PRQ(3)
      KC=1
      IF(MSE-MSL)65,65,79
65    MSE=MSL
      PREQ=PRQ(3)
      KE=1
      GO TO 85
69    IF(MST-MSM)70,70,81
70    MST=MSM
      PRTQ=PRQ(2)
      KT=2
74    IF(MSC-MSM)75,75,82
75    MSC=MSM
      PRCQ=PRQ(2)
      KC=2
79    IF(MSE-MSM)80,80,83
80    MSE=MSM
      PREQ=PRQ(2)
      KE=2
      GO TO 85
81    MST=MSH
      PRTQ=PRQ(1)
      KT=3
82    MSC=MSH
      PRCQ=PRQ(1)
      KC=3
83    MSE=MSH
      PREQ=PRQ(1)
      KE=3
C
C
C
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```
C
C
C
85    IF(MST-MSC)90,87,87
87    IF(MST-MSE)89,88,88
88    K=1
      GO TO 95
89    K=3
      GO TO 95
90    IF(MSC-MSE)91,92,92
91    K=4
      GO TO 95
92    K=2
C
95    SMT=STR(MST)
      GO TO (105,100),KSW
100   SME=0.
      SMC=0.
      PREQ=0.
      PRCQ=0.
      MSE=0
      MSC=0
      GO TO 390
105   SME=STR(MSE)
      SMC=STR(MSC)
390   RETURN
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR ISSUE
 COMMON     424  VARIABLES       2  PROGRAM    276

 END OF COMPILATION
```

```
// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE NSPEC(J)
C
C  COMPUTE MINIMUM INSPECTION FREQUENCY
C
      REAL MSBDE,MSBDC,MSBDT,MSBDR,MSBDO
C
      DIMENSION A(5),XNL(17),NAFPC(17),NAME(3),STR(25),
     1 LIFE(17),PRQ(3),WTQ(3)
C
      COMMON     K,KE,KC,KT,MSE,MSC,MST,SS,SLF,SLC,SLT,SL,PRF,PRC,PRT,
     1 PRS,RA,RS,RP,EF,TS,XMH,AV,DT,SO,PC,S1,P1,PREQ,PRCQ,PRTQ,PRSC,XNL,
     2WTE,WTC,WTT,A,A1,A2,A3,AL,AM,AH,TONL,TONM,TONH,TONE,TONC,TONT,TON,
     3CI,CIR,CSOCA,CSOCS,CSCCA,CSCCS,CSCFA,CSCFS,CSTA,CSTS,CP,RMH,CR,T3,
     4 CSAB,CSSB,CSACR,CSSCR,CFA,CFS,CM,CTA,CTS,CEA,CES,CEQ, RL,TL,VAL1,
     5 MSH,MSM,MSL,NOGO,SNE,SNC,SNT,MSBDE,MSBDC,MSBDT,MSBDR,MSBDO,VAL2
      COMMON R3,R23,S,DTQ,CCN,XLOG,RVC,TT,WF,DCFA,DCFS,KSW,NM,KASE,SPTS
      COMMON PMH,RRE,RRC,RRT,STR,LIFE,      WFACT,RFACT,CW,WA,WS,WP
      COMMON   NAME,V1,V2,T1,T2,AQ,IS,PB,QMH,SLQ,SP,C,CN,PRQ,WTQ,PC
      COMMON   CFACT,COPS,COPA,CCFS,CCFA,CPMH,CPEH,CPEHI
      COMMON     NO,DOPA,DOPS,DCCA,DCCS,DCCSA,TLONG,CCCA,CCCS,NAFPC
C
      BAR(XX,YY)=1./(1./XX+1./YY)
C
      GO TO (95,80),KSW
80    MSBDT=272.*(SNT/XNL(J))**3
      MSBDC=0.
      MSBDE=0.
      MSBDR=MSBDT
      MSBDO=MSBDT
      GO TO 99
C
95    MSBDE=4.25*(SNE/XNL(J))**3
      MSBDC=34.0*(SNC/XNL(J))**3
      MSBDT=272.*(SNT/XNL(J))**3
      MSBDR=BAR(MSBDE,MSBDC)
      MSBDO=BAR(MSBDR,MSBDT)
C
99    I01= IFIX(VAL1/(DTQ-TT/MSBDR)+1.)
      I02= IFIX(XLOG*MSBDR)
      IF(I02-1 )100,115,105
100   I02=1
      GO TO 115
105   IF(I02-IS)115,115,110
110   I02=IS
115   IF(I01-I02)125,125,120
120   IF(I01-IS)122,122,124
122   SO=I01
      GO TO 127
124   SO=IS
      GO TO 127
125   SO=I02
127   GO TO (128,390),KSW
C
128   I11= IFIX(VAL2*CCN/(QMH-(T3+VAL1)*CCN/SO-T2/MSBDO)+1.)
      I12= IFIX(XLOG*MSBDT)
      IF(I12-1 )130,145,135
130   I12=1
C
C
C
```

```
C
C
C
      GO TO 145
135   IF(I12-IS)145,145,140
140   I12=IS
145   IF(I11-I12)155,155,150
150   IF(I11-IS)152,152,154
152   S1=I11
      GO TO 300
154   S1=IS
      GO TO 300
155   S1=I12
C
300   RETURN
C
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR NSPEC
 COMMON      424  VARIABLES      14  PROGRAM     324

 END OF COMPILATION
```

```
// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE EFECT(J)
C
C   COMPUTE EFFECTIVENESS
C
      REAL MSBDE,MSBDC,MSBDT,MSBDR,MSBDO
C
      DIMENSION A(5),XNL(17),NAFPC(17),NAME(3),STR(25),
     1 LIFE(17),PRQ(3),WTQ(3)
C
      COMMON     K,KE,KC,KT,MSE,MSC,MST,SS,SLE,SLC,SLT,SL,PRE,PRC,PRT,
     1 PRS,RA,RS,RP,EF,TS,XMH,AV,DT,S0,P0,S1,P1,PREQ,PRCQ,PRTQ,PRSQ,XNL,
     2WTE,WTC,WTT,A,A1,A2,A3,AL,AM,AH,TONL,TONM,TONH,TONE,TONC,TONT,TON,
     3CI,CIR,CSOCA,CSOCS,CSCCA,CSCCS,CSCFA,CSCFS,CSTA,CSTS,CP,RMH,CR,T3,
     4 CSAB,CSSB,CSACR,CSSCR,CFA,CFS,CM,CTA,CTS,CEA,CES,CEQ, RL,TL,VAL1,
     5 MSH,MSM,MSL,NOGO,SNE,SNC,SNT,MSBDE,MSBDC,MSBDT,MSBDR,MSBDO,VAL2
      COMMON R3,R23,S,DTQ,CCN,XLOG,RVC,TT,WF,DCFA,DCFS,KSW,NM,KASE,SPTS
      COMMON PMH,RRE,RRC,RRT,STR,LIFE,      WFACT,RFACT,CW,WA,WS,WP
      COMMON   NAME,V1,V2,T1,T2,AQ,IS,PB,QMH,SLQ,SP,C,CN,PRQ,WTQ,PC
      COMMON   CFACT,COPS,COPA,CCFS,CCFA,CPMH,CPEH,CPEHI
      COMMON     NO,DOPA,DOPS,DCCA,DCCS,DCCSA,TLONG,CCCA,CCCS,NAFPC
C
C  COMPUTE DOWNTIME, AVAILABILITY, MAINTENANCE MANHOURS
      GO TO (150,100),KSW
C
C  HELIPORTS
100   DT=VAL1/S0+TT/MSBDT
      AV=(1.-S*DT/24.)*100.
      SS=24.*(1.-AQ/100.)/DT
      XMH=(T3+VAL1)*CCN/S0+T2/MSBDT
      SLT=272.* A(5)*SP*(SNT/XNL(J))**4/55.
      SLE=0.
      SLC=0.
      SL=SLT
      IF(SL-SLQ)115,115,110
110   SLL=SLQ
      GO TO 120
115   SLL=SL
120   P0=EXP(-S0/MSBDT)
      P1=0.
      WTE=0.
      WTC=0.
      WTT=SNT/CW+.034
      PRE=0.
      PRC=0.
      PRT=50./WTT**2
      PMH=A(3)/PRT
      PRS=PMH* S/PC/24.
      PRSQ=A(3)* S/PRTQ/PC/24.
      RRE=0.
      RRC=0.
      RRT=75./WTT**0.875
      GO TO 185
C
C  AIRFIELDS
150   DT=VAL1/S0+TT/MSBDR
      AV=(1.-S*DT/24.)*100.
      SS=24.*(1.-AQ/100.)/DT
C
C
C
```

```
C
C
C
      XMH=(T3/S0+VAL1/S0+VAL2/S1+T2/CCN/MSBDO)*CCN
      P0=EXP(-S0/MSBDR)
      P1=EXP(-S1/MSBDT)
C  COMPUTE SERVICE LIFE
      GO TO (160,165,170,175),K
160   SLE=272./73.*A(5)*SP*(SNE/XNL(J))**4/55.
      SLC=SLE
      SLT=SLE
      SL=SLE
      GO TO 180
165   SLE=34.0/9.0*A(4)*SP*(SNE/XNL(J))**4/55.
      SLC=SLE
      SLT=272.*A(3)*SP*(SNT/XNL(J))**4/55.
      SL=(SLE+SLT)/2.
      GO TO 180
170   SLE=4.25*A(1)*SP*(SNE/XNL(J))**4/55.
      SLC=272./9.*(A(2)+A(3))*SP*(SNC/XNL(J))**4/55.
      SLT=SLC
      SL=(SLE+SLT)/2.
      GO TO 180
175   SLE=4.25*A(1)*SP*(SNE/XNL(J))**4/55.
      SLC=34.0*A(2)*SP*(SNC/XNL(J))**4/55.
      SLT=272.0*A(3)*SP*(SNT/XNL(J))**4/55.
      SL=(SLE+SLC+SLT)/3.
180   IF(SL-SLQ)182,182,181
181   SLL=SLQ
      GO TO 183
182   SLL=SL
C
C  COMPUTE WEIGHT AND PLACEMENT RATE
183   WTE=SNE/CW+.034
      WTC=SNC/CW+.034
      WTT=SNT/CW+.034
      PRE=50./WTE**2
      PRC=50./WTC**2
      PRT=50./WTT**2
      PMH=A(1)/PRE+A(2)/PRC+A(3)/PRT
      PRS=PMH* S/PC/24.
      PRSQ=(A(1)/PREQ+A(2)/PRCQ+A(3)/PRTQ)* S/PC/24.
C
C  ALSO GET RECOVERY RATE
      RRE=75./WTE**0.875
      RRC=75./WTC**0.875
      RRT=75./WTT**0.875
C
C  NORMALIZE AVAILABILITY, SERVICE LIFE, AND PLACEMENT RATE WITH QMR VALUES
185   RA=SS/S
      IF(RA-1.)200,200,190
190   CALL DATSW(13,ISW13)
      GO TO (192,194),ISW13
192   RA=1.
      GO TO 200
194   RA=2.*(1.-1./2.**RA)
200   RS=SLL/SLQ
      RP=PRSQ/PRS
      IF(RP-1.)210,210,205
205   GO TO (207,210),ISW13
207   RP=1.
C  COMPUTE EFFECTIVENESS
210   EF=(WA*RA+WS*RS+WP*RP)/(WA+WS+WP)
C
C
C
```

```
C
C
C
C
C  COMPUTE NUMBER OF SORTIES DURING LIFE OF AIRFIELD
      TS=S*LIFE(J)
      IF(J-17)230,220,220
220   TS=5400.
230   SPTS=SP*TS
C
      RETURN
C
      END
```

FEATURES SUPPORTED
ONE WORD INTEGERS

CORE REQUIREMENTS FOR EFECT
COMMON 424 VARIABLES 14 PROGRAM 938

END OF COMPILATION

```
// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE COST
C
      REAL MSBDE,MSBDC,MSBDT,MSBDR,MSBDO
C
      DIMENSION A(5),XNL(17),NAFPC(17),NAME(3),STR(25),
     1 LIFE(17),PRQ(3),WTQ(3)
C
      COMMON      K,KE,KC,KT,MSE,MSC,MST,SS,SLE,SLC,SLT,SL,PRE,PRC,PRT,
     1 PRS,RA,RS,RP,EF,TS,XMH,AV,DT,S0,P0,S1,P1,PREQ,PRCQ,PRTQ,PRSQ,XNL,
     2WTE,WTC,WTT,A,A1,A2,A3,AL,AM,AH,TONL,TONM,TONH,TONE,TONC,TONT,TON,
     3CI,CIR,CSOCA,CSOCS,CSCCA,CSCCS,CSCFA,CSCFS,CSTA,CSTS,CP,RMH,CR,T3,
     4 CSAB,CSSB,CSACR,CSSCR,CFA,CFS,CM,CTA,CTS,CEA,CES,CEQ, RL,TL,VAL1,
     5 MSH,MSM,MSL,NOGO,SNE,SNC,SNT,MSBDE,MSBDC,MSBDT,MSBDR,MSBDO,VAL2
      COMMON R3,R23,S,DTQ,CCN,XLOG,RVC,TT,WF,DCFA,DCFS,KSW,NM,KASE,SPTS
      COMMON PMH,RRE,RRC,RRT,STR,LIFE,       WFACT,RFACT,[illegible],WA,WS,WP
      COMMON    NAME,V1,V2,T1,T2,AQ,IS,PB,QMH,SLQ,SP,C,CN,PRQ,WTQ,PC
      COMMON    CFACT,COPS,COPA,CCFS,CCFA,CPMH,CPEH,CPEHI
      COMMON      NO,DOPA,DOPS,DCCA,DCCS,DCCSA,TLONG,CCCA,CCCS,NAFPC
C
C   ADJUST AREA OF MATERIAL REQUIRED FOR AIRFIELD LIFE
      A1=A(1)*(1.+SPTS/SLE)
      A2=A(2)*(1.+SPTS/SLC)
      A3=A(3)*(1.+SPTS/SLT)
C
C   COMPUTE INITIAL COST OF MEMBRANE AND REPLACEMENT PARTS
      CI=(A1*WTE+A2*WTC+A3*WTT)*CFACT+(A1+A2+A3)*0.1
C
C   COMPUTE ORIGIN-CONUS PORT, CONUS-COMMZ, COMMZ-FIELD, AND TOTAL SHIPPING COS
      TONE=A1*WTE*WF
      TONC=A2*WTC*WF
      TONT=A3*WTT*WF
      TON=TONE+TONC+TONT
      TONL=0.
      TONM=0.
      TONH=0.
      AL=0.
      AM=0.
      AH=0.
      GO TO (200,202,204),KE
200   TONL=TONL+TONE
      AL=AL+A1
      GO TO 206
202   TONM=TONM+TONE
      AM=AM+A1
      GO TO 206
204   TONH=TONH+TONE
      AH=AH+A1
206   GO TO (208,210,212),KC
208   TONL=TONL+TONC
      AL=AL+A2
      GO TO 214
210   TONM=TONM+TONC
      AM=AM+A2
      GO TO 214
212   TONH=TONH+TONC
      AH=AH+A2
214   GO TO (216,218,220),KT
C
C
C
```

```
C
C
C
216   TONL=TONL+TONT
      AL=AL+A3
      GO TO 225
218   TONM=TONM+TONT
      AM=AM+A3
      GO TO 225
220   TONH=TONH+TONT
      AH=AH+A3
225   CSOCA=COPA*DOPA*TON
      CSOCS=COPS*DOPS*TON
      CSCCA=CCCA*DCCA*TON
      CSCCS=(CCCS*DCCS+CCCA*DCCSA)*TON
      CSCFA=CCFA*DCFA*TON
      CSCFS=CCFS*DCFS*TON
      CSTA=CSOCA+CSCCA+CSCFA
      CSTS=CSOCS+CSCCS+CSCFS
C
C  COMPUTE PLACEMENT COST
      CEQ=CPEH*(A(5)/1000.)**1.5/40.
      CP=CPMH*PMH+CEQ
C
C  COMPUTE RECOVERY COST
      RMH=(A(1)/RRE+A(2)/RRC+A(3)/RRT)*RFACT
      CR=RMH*CPMH+CEQ
C
C COMPUTE COST OF SHIPPING SERVICEABLE MEMBRANE BACK TO COMMZ
      TONR=TON*RFACT
      CSAB=CCFA*DCFA*TONR
      CSSB=CCFS*DCFS*TONR
C
C  COMPUTE VALUE OF RECOVERED MEMBRANE AT COMMZ
      CIR=((A(1)*WTE+A(2)*WTC+A(3)*WTT)*CFACT+(A(1)+A(2)+A(3))*.1)*RFACT
      CSACR=(COPA*DOPA+CCCA*DCCA)*TONR
      CSSCR=(COPS*DOPS+CCCS*DCCS+CCCA*DCCSA)*TONR
C
C  COMPUTE MEMBRANE TOTAL FIXED COST
      CFA=(CI+CSTA-CIR-CSACR+CSAB+CP+CR)
      CFS=(CI+CSTS-CIR-CSSCR+CSSB+CP+CR)
C
C  COMPUTE MAINTENANCE COST PER LIFE OF FIELD
      CM=XMH*(CPMH+CPEH/CCN)*TS
C
C  COMPUTE TOTAL COST PER LIFE OF AIRFIELD
      CTA=CFA+CM
      CTS=CFS+CM
C
C  COMPUTE COST EFFECTIVENESS
      CEA=CTA/EF
      CES=CTS/EF
C
      RETURN
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR COST
 COMMON     424  VARIABLES     12  PROGRAM    598

 END OF COMPILATION
```

APPENDIX C

COST EFFECTIVENESS DATA

SYSTEM 1 - 1 LIGHT= 0 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	21	21	21	99.5	108.2	639647.	56.	56.	56.	59.	1.99	1.00	0.28	1.55
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	21	98.8	42.9	2797042.	0.	0.	56.	59.	1.97	1.00	0.28	1.53
2	6	21	21	21	99.5	105.8	650260.	56.	56.	56.	60.	1.99	1.00	0.28	1.55
2	10	21	21	21	99.2	68.4	340237.	56.	56.	56.	127.	1.99	1.00	0.28	1.55
2	17	0	0	21	98.8	42.9	2797042.	0.	0.	56.	59.	1.97	1.00	0.28	1.53
3	6	21	21	21	99.5	102.9	663531.	56.	56.	56.	62.	1.99	1.00	0.28	1.55
3	10	21	21	21	99.2	66.7	345193.	56.	56.	56.	129.	1.99	1.00	0.28	1.55
3	17	0	0	21	98.8	42.9	2797042.	0.	0.	56.	59.	1.97	1.00	0.28	1.53
4	6	21	21	21	99.3	81.0	793285.	56.	56.	56.	74.	1.99	1.00	0.28	1.55
4	10	21	21	21	99.0	53.5	393034.	56.	56.	56.	147.	1.99	1.00	0.28	1.54
4	17	0	0	21	98.8	42.9	2797042.	0.	0.	56.	59.	1.97	1.00	0.28	1.53
5	6	21	21	21	99.1	55.9	1066849.	56.	56.	56.	100.	1.99	1.00	0.28	1.55
5	10	21	21	21	93.7	37.8	495819.	56.	56.	56.	185.	1.95	1.00	0.28	1.52
5	17	0	0	21	93.8	42.9	2797042.	0.	0.	56.	59.	1.97	1.00	0.28	1.53

SYSTEM 1 - 1   LIGHT= 0 MEDIUM= 0 HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

	AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)							
	AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1 6	0.	0.	406.	0.	0.	296.	296.	68.	19.	60.	5.	17.3	5.2	146.	30.
1 10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1 17	0.	0.	405.	0.	0.	295.	295.	67.	19.	60.	5.	17.2	5.2	145.	30.
1 TOT	0.	0.	26485.	0.	0.	19305.	19305.	4442.	1279.	3938.	345.	1092.8	329.2	9473.	1953.
2 6	0.	0.	413.	0.	0.	301.	301.	99.	28.	151.	6.	4.4	1.3	255.	36.
2 10	0.	0.	865.	0.	0.	630.	630.	209.	60.	317.	13.	6.1	1.8	532.	75.
2 17	0.	0.	405.	0.	0.	295.	295.	97.	28.	148.	6.	4.3	1.3	250.	35.
2 TOT	0.	0.	20009.	0.	0.	14584.	14584.	4834.	1398.	7337.	307.	207.1	62.4	12379.	1768.
3 6	0.	0.	421.	0.	0.	307.	307.	101.	29.	222.	8.	3.3	1.0	327.	39.
3 10	0.	0.	877.	0.	0.	639.	639.	212.	61.	462.	17.	4.6	1.4	678.	80.
3 17	0.	0.	405.	0.	0.	295.	295.	97.	28.	213.	8.	3.2	0.9	314.	37.
3 TOT	0.	0.	7409.	0.	0.	5400.	5400.	1790.	517.	3901.	150.	56.9	17.1	5748.	685.
4 6	0.	0.	504.	0.	0.	367.	367.	84.	24.	118.	34.	4.0	1.2	206.	59.
4 10	0.	0.	1000.	0.	0.	729.	729.	167.	48.	234.	68.	5.3	1.6	407.	117.
4 17	0.	0.	405.	0.	0.	295.	295.	67.	19.	94.	27.	3.2	0.9	166.	48.
4 TOT	0.	0.	25703.	0.	0.	18735.	18735.	4310.	1241.	6019.	1747.	202.8	61.1	10533.	3049.
5 6	0.	0.	678.	0.	0.	494.	494.	28.	7.	154.	72.	5.4	1.6	188.	81.
5 10	0.	0.	1260.	0.	0.	918.	918.	53.	14.	286.	134.	6.7	2.0	346.	150.
5 17	0.	0.	405.	0.	0.	295.	295.	17.	4.	91.	43.	3.2	0.9	112.	48.
5 TOT	0.	0.	8562.	0.	0.	6240.	6240.	365.	96.	1944.	911.	65.0	19.6	2374.	1028.
TOTAL	0.	0.	88170.	0.	0.	64266.	64266.	15743.	4533.	23141.	3462.	1624.8	489.5	40509.	8486.

SYSTEM 1 - 1 LIGHT= 0 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

- - - - - - - - - - - - - - - - SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000) - - - - - - - - - - - - - - - -

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	882.	146.	30.	26.	17.	15.6	4.7	909.	816.	178.	144.	0.058	178.	144.	114.	92.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	878.	145.	30.	25.	17.	15.5	4.6	905.	813.	177.	144.	3.127	180.	147.	117.	95.
1	TOT		57450.	9473.	1953.	1707.	1172.	983.5	296.3	59239.	53159.	186.	151.	2.402	183.	154.	122.	100.
2	6	98.	897.	255.	36.	26.	18.	3.9	1.1	1033.	839.	168.	140.	0.060	168.	140.	107.	90.
2	10	420.	1876.	532.	75.	58.	41.	5.5	1.6	2162.	1755.	351.	298.	0.421	352.	298.	226.	192.
2	17	5400.	878.	250.	35.	25.	17.	3.8	1.1	1012.	821.	164.	137.	3.127	167.	140.	109.	91.
2	TOT		43403.	12379.	1768.	1289.	885.	186.4	56.1	50011.	40591.	173.	144.	2.620	175.	147.	114.	95.
3	6	98.	915.	327.	39.	27.	18.	3.0	0.9	1115.	858.	176.	143.	0.061	176.	143.	113.	91.
3	10	420.	1903.	678.	80.	59.	41.	4.2	1.2	2320.	1784.	368.	302.	0.429	368.	302.	237.	194.
3	17	5400.	878.	314.	37.	25.	17.	2.9	0.8	1070.	823.	169.	137.	3.127	172.	140.	112.	91.
3	TOT		16072.	5748.	685.	478.	328.	51.2	15.4	19585.	15064.	182.	148.	2.427	184.	150.	119.	97.
4	6	98.	1094.	206.	59.	32.	22.	3.6	1.0	1167.	1037.	192.	173.	0.075	192.	173.	123.	111.
4	10	420.	2171.	407.	117.	68.	48.	4.8	1.4	2315.	2058.	384.	348.	0.515	385.	349.	248.	225.
4	17	5400.	878.	166.	48.	25.	17.	2.9	0.8	937.	833.	154.	138.	3.127	157.	141.	102.	92.
4	TOT		55753.	10533.	3049.	1654.	1135.	132.5	54.9	59466.	52859.	160.	144.	2.884	163.	146.	106.	95.
5	6	98.	1471.	188.	81.	45.	31.	4.8	1.4	1489.	1396.	252.	234.	0.105	252.	234.	162.	151.
5	10	420.	2734.	346.	150.	88.	62.	6.0	1.8	2767.	2594.	471.	443.	0.694	471.	443.	309.	291.
5	17	5400.	878.	112.	48.	25.	17.	2.9	0.8	888.	833.	148.	138.	3.127	152.	141.	98.	92.
5	TOT		18572.	2374.	1028.	561.	387.	58.5	17.6	18791.	17620.	186.	173.	2.451	188.	175.	122.	114.
TOTAL			191251.	40509.	8486.	5692.	3909.	1462.3	440.5	207095.	179295.	175.	149.	2.603	177.	152.	115.	98.

SYSTEM 1 - 2   LIGHT= 0 MEDIUM= 0 HEAVY=17   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	17	17	17	99.3	76.4	118459.	126.	126.	126.	26.	1.99	1.00	0.63	1.62
1	10	17	17	17	97.5	19.9	62276.	126.	126.	126.	56.	1.72	1.00	0.63	1.43
1	17	0	0	17	98.8	42.4	517998.	0.	0.	126.	26.	1.96	1.00	0.63	1.60
2	6	17	17	17	99.3	75.0	120425.	126.	126.	126.	27.	1.99	1.00	0.63	1.62
2	10	17	17	17	97.4	19.5	63010.	126.	126.	126.	56.	1.71	1.00	0.63	1.42
2	17	0	0	17	98.8	42.4	517998.	0.	0.	126.	26.	1.96	1.00	0.63	1.60
3	6	17	17	17	99.3	73.3	122882.	126.	126.	126.	27.	1.99	1.00	0.63	1.62
3	10	17	17	17	97.4	19.0	63928.	126.	126.	126.	57.	1.69	1.00	0.63	1.41
3	17	0	0	17	98.8	42.4	517998.	0.	0.	126.	26.	1.96	1.00	0.63	1.60
4	6	17	17	17	99.1	59.8	146912.	126.	126.	126.	33.	1.99	1.00	0.63	1.62
4	10	17	17	17	96.7	15.2	72899.	126.	126.	126.	65.	1.55	1.00	0.63	1.31
4	17	0	0	17	98.8	42.4	517998.	0.	0.	126.	26.	1.96	1.00	0.63	1.60
5	6	17	17	17	98.8	43.1	197575.	126.	126.	126.	44.	1.97	1.00	0.63	1.60
5	10	17	17	17	95.4	10.8	91823.	126.	126.	126.	83.	1.31	1.00	0.63	1.14
5	17	0	0	17	98.8	42.4	517998.	0.	0.	126.	26.	1.96	1.00	0.63	1.60

SYSTEM 1 - 2 LIGHT= 0 MEDIUM= 0 HEAVY=17 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

	AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)							
	AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1 6	0.	0.	406.	0.	0.	198.	198.	45.	13.	40.	3.	11.5	3.4	97.	20.
1 10	0.	0.	855.	0.	0.	416.	416.	95.	27.	85.	7.	16.2	4.8	197.	39.
1 17	0.	0.	405.	0.	0.	197.	197.	45.	13.	40.	3.	11.5	3.4	97.	20.
1 TOT	0.	0.	26503.	0.	0.	12913.	12913.	2971.	855.	2634.	230.	731.0	220.2	6336.	1306.
2 6	0.	0.	413.	0.	0.	201.	201.	66.	19.	101.	4.	2.9	0.8	171.	24.
2 10	0.	0.	865.	0.	0.	421.	421.	139.	40.	212.	8.	4.1	1.2	356.	50.
2 17	0.	0.	405.	0.	0.	197.	197.	65.	18.	99.	4.	2.8	0.8	167.	23.
2 TOT	0.	0.	20024.	0.	0.	9756.	9756.	3234.	935.	4908.	205.	138.5	41.7	8281.	1182.
3 6	0.	0.	422.	0.	0.	205.	205.	68.	19.	148.	5.	2.2	0.6	218.	26.
3 10	0.	0.	878.	0.	0.	427.	427.	141.	41.	309.	11.	3.1	0.9	454.	53.
3 17	0.	0.	405.	0.	0.	197.	197.	65.	18.	142.	5.	2.1	0.6	210.	25.
3 TOT	0.	0.	7414.	0.	0.	3612.	3612.	1197.	346.	2609.	100.	38.0	11.4	3845.	458.
4 6	0.	0.	504.	0.	0.	245.	245.	56.	16.	78.	22.	2.6	0.8	138.	40.
4 10	0.	0.	1001.	0.	0.	487.	487.	112.	32.	156.	45.	3.5	1.0	272.	78.
4 17	0.	0.	405.	0.	0.	197.	197.	45.	13.	63.	18.	2.1	0.6	111.	32.
4 TOT	0.	0.	25723.	0.	0.	12532.	12532.	2883.	830.	4026.	1168.	135.6	40.8	7046.	2040.
5 6	0.	0.	678.	0.	0.	330.	330.	19.	5.	102.	48.	3.6	1.0	125.	54.
5 10	0.	0.	1261.	0.	0.	614.	614.	35.	9.	191.	89.	4.4	1.3	231.	100.
5 17	0.	0.	405.	0.	0.	197.	197.	11.	3.	61.	28.	2.1	0.6	75.	32.
5 TOT	0.	0.	8567.	0.	0.	4174.	4174.	244.	64.	1300.	609.	43.5	13.1	1587.	687.
TOTAL	0.	0.	88232.	0.	0.	42988.	42988.	10531.	3032.	15479.	2316.	1086.8	327.4	27097.	5676.

SYSTEM 1 - 2   LIGHT= 0   MEDIUM= 0   HEAVY=17   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	603.	97.	20.	13.	13.	10.4	3.1	620.	557.	117.	95.	0.066	117.	95.	72.	58.
1	10	420.	1268.	197.	39.	31.	31.	14.6	4.4	1304.	1172.	238.	202.	0.891	239.	203.	167.	142.
1	17	5400.	601.	97.	20.	13.	13.	10.3	3.1	617.	555.	117.	95.	3.148	121.	98.	75.	61.
1	TOT		39306.	6336.	1306.	878.	886.	657.9	198.2	40391.	36324.	123.	100.	2.442	126.	103.	79.	64.
2	6	98.	613.	171.	24.	13.	13.	2.6	0.7	703.	573.	111.	92.	0.068	111.	92.	68.	57.
2	10	420.	1283.	356.	50.	31.	31.	3.7	1.1	1471.	1199.	235.	199.	0.908	236.	200.	165.	140.
2	17	5400.	601.	167.	23.	13.	13.	2.5	0.7	688.	561.	109.	91.	3.148	112.	94.	70.	58.
2	TOT		29697.	8281.	1182.	663.	669.	124.7	37.5	34032.	27730.	114.	96.	2.659	117.	98.	73.	62.
3	6	98.	625.	218.	26.	13.	14.	2.0	0.6	758.	586.	116.	94.	0.069	116.	94.	71.	58.
3	10	420.	1302.	454.	53.	31.	32.	2.8	0.8	1577.	1219.	246.	202.	0.929	247.	203.	174.	143.
3	17	5400.	601.	210.	25.	13.	13.	1.9	0.5	727.	562.	112.	91.	3.148	115.	94.	71.	58.
3	TOT		10996.	3845.	458.	246.	248.	34.2	10.3	13315.	10291.	120.	98.	2.474	123.	100.	77.	63.
4	6	98.	748.	138.	40.	17.	17.	2.4	0.7	795.	708.	127.	114.	0.085	127.	114.	78.	70.
4	10	420.	1485.	272.	78.	37.	37.	3.2	0.9	1573.	1405.	257.	233.	1.132	258.	234.	196.	178.
4	17	5400.	601.	111.	32.	13.	13.	1.9	0.5	638.	568.	102.	91.	3.148	105.	94.	65.	59.
4	TOT		38149.	7046.	2040.	850.	857.	122.1	36.7	40521.	36101.	106.	95.	2.914	109.	98.	68.	61.
5	6	98.	1006.	125.	54.	23.	23.	3.2	0.9	1015.	953.	167.	155.	0.117	167.	155.	104.	97.
5	10	420.	1870.	231.	100.	48.	49.	4.0	1.2	1887.	1772.	316.	298.	1.561	318.	299.	277.	261.
5	17	5400.	601.	75.	32.	13.	13.	1.9	0.5	606.	569.	98.	91.	3.148	101.	94.	63.	59.
5	TOT		12705.	1587.	687.	292.	295.	39.1	11.8	12817.	12034.	123.	115.	2.520	126.	117.	83.	77.
TOTAL			130856.	27097.	5676.	2931.	2956.	978.1	294.7	141078.	122482.	116.	99.	2.642	119.	101.	75.	64.

SYSTEM 2 - 1   LIGHT= 7 MEDIUM= 0 HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	7	7	7	93.1	7.1	1742.	860.	360.	860.	3.	1.01	1.00	2.15	1.24
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
2	6	21	21	21	99.5	105.8	650260.	56.	56.	56.	60.	1.99	1.00	0.28	1.55
2	10	21	21	7	99.2	68.4	73715.	56.	56.	860.	42.	1.99	1.00	0.54	1.60
2	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
3	6	21	7	7	98.0	24.6	61081.	56.	860.	860.	12.	1.82	1.00	0.80	1.53
3	10	21	21	7	99.2	66.7	75470.	56.	56.	860.	43.	1.99	1.00	0.53	1.60
3	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
4	6	21	21	21	99.3	81.0	793285.	56.	56.	56.	74.	1.99	1.00	0.28	1.55
4	10	21	21	7	99.0	53.5	92635.	56.	56.	860.	55.	1.99	1.00	0.49	1.59
4	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
5	6	21	21	7	99.1	55.9	333148.	56.	56.	860.	55.	1.99	1.00	0.38	1.57
5	10	21	21	7	98.7	37.8	128822.	56.	56.	860.	80.	1.95	1.00	0.45	1.55
5	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46

SYSTEM 2 - 1   LIGHT= 7 MEDIUM= 0 HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

	AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							T R A N S P O R T A T I O N C O S T S ($ 1 0 0 0)							
	AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1 6	409.	0.	0.	76.	0.	0.	76.	17.	5.	15.	1.	4.4	1.3	37.	7.
1 10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1 17	433.	0.	0.	81.	0.	0.	81.	18.	5.	16.	1.	4.7	1.4	39.	8.
1 TOT	25292.	0.	2565.	4726.	0.	1869.	6595.	1517.	437.	1345.	117.	349.3	105.2	3212.	660.
2 6	0.	0.	413.	0.	0.	301.	301.	99.	28.	151.	6.	4.4	1.7	255.	36.
2 10	616.	0.	248.	115.	0.	181.	296.	98.	28.	149.	6.	2.8	0.8	250.	35.
2 17	433.	0.	0.	81.	0.	0.	81.	26.	7.	40.	1.	1.1	0.3	68.	9.
2 TOT	18147.	0.	2979.	3390.	0.	2171.	5562.	1843.	533.	2798.	117.	78.4	23.6	4720.	674.
3 6	361.	0.	61.	67.	0.	44.	112.	37.	10.	80.	3.	1.2	0.3	119.	14.
3 10	621.	0.	256.	116.	0.	187.	303.	100.	29.	219.	8.	2.2	0.6	321.	38.
3 17	433.	0.	0.	81.	0.	0.	81.	26.	7.	58.	2.	0.8	0.2	86.	10.
3 TOT	7342.	0.	440.	1372.	0.	320.	1692.	561.	162.	1222.	47.	17.4	5.2	1801.	214.
4 6	0.	0.	504.	0.	0.	367.	367.	84.	24.	118.	34.	4.0	1.2	206.	59.
4 10	667.	0.	333.	124.	0.	243.	368.	84.	24.	118.	34.	2.6	0.8	205.	59.
4 17	433.	0.	0.	81.	0.	0.	81.	18.	5.	26.	7.	0.8	0.2	45.	13.
4 TOT	24954.	0.	2351.	4662.	0.	1714.	6377.	1467.	422.	2048.	594.	68.6	20.6	3584.	1037.
5 6	324.	0.	354.	60.	0.	258.	318.	18.	4.	99.	46.	3.4	1.0	121.	52.
5 10	765.	0.	496.	142.	0.	361.	504.	29.	7.	157.	73.	3.6	1.1	190.	82.
5 17	433.	0.	0.	81.	0.	0.	81.	4.	1.	25.	11.	0.8	0.2	30.	13.
5 TOT	7375.	0.	1559.	1378.	0.	1136.	2514.	147.	39.	783.	367.	25.7	7.7	956.	414.
TOTAL	83114.	0.	9895.	15530.	0.	7212.	22743.	5537.	1594.	8199.	1244.	539.6	162.5	14276.	3001.

SYSTEM 2 - 1 LIGHT= 7 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

- - - - - - - - - - - - - - - - - SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000) - - - - - - - - - - - - - - - - -

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	257.	37.	7.	4.	7.	4.0	1.2	260.	236.	51.	42.	0.330	51.	42.	41.	34.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	273.	39.	8.	4.	7.	4.2	1.2	261.	235.	68.	59.	11.591	79.	70.	54.	48.
1	TOT		21509.	3212.	660.	442.	566.	314.4	94.7	21153.	19076.	78.	67.	8.871	87.	76.	60.	52.
2	6	98.	897.	255.	36.	26.	18.	3.9	1.1	1033.	839.	168.	140.	0.050	168.	140.	107.	90.
2	10	420.	928.	250.	35.	25.	25.	2.6	0.7	1058.	866.	174.	149.	0.439	175.	150.	109.	93.
2	17	5400.	273.	68.	9.	4.	7.	1.0	0.3	290.	238.	64.	57.	11.591	76.	68.	52.	47.
2	TOT		17902.	4720.	674.	389.	453.	70.6	21.2	19654.	16062.	82.	71.	9.645	92.	81.	61.	54.
3	6	98.	360.	119.	14.	8.	9.	1.1	0.3	430.	336.	67.	55.	0.146	68.	55.	44.	36.
3	10	420.	948.	321.	38.	26.	25.	1.9	0.6	1141.	887.	184.	152.	0.447	184.	153.	114.	95.
3	17	5400.	273.	86.	10.	4.	7.	0.8	0.2	306.	238.	65.	57.	11.591	77.	68.	53.	47.
3	TOT		5584.	1801.	214.	110.	152.	15.7	4.7	6418.	5001.	73.	62.	8.916	82.	71.	55.	48.
4	6	98.	1094.	206.	59.	32.	22.	3.6	1.0	1167.	1037.	192.	173.	0.075	192.	173.	123.	111.
4	10	420.	1145.	205.	59.	33.	31.	2.4	0.7	1212.	1082.	205.	187.	0.532	205.	187.	129.	117.
4	17	5400.	273.	45.	13.	4.	7.	0.8	0.2	270.	241.	61.	57.	11.591	73.	69.	50.	47.
4	TOT		20833.	3584.	1037.	420.	543.	61.7	18.6	21002.	18753.	72.	67.	10.655	83.	77.	56.	52.
5	6	98.	973.	121.	52.	27.	23.	3.1	0.9	981.	922.	166.	155.	0.107	166.	155.	106.	98.
5	10	420.	1558.	190.	82.	47.	43.	3.3	1.0	1570.	1475.	273.	257.	0.712	273.	258.	175.	165.
5	17	5400.	273.	30.	13.	4.	7.	0.8	0.2	256.	241.	60.	57.	11.591	72.	69.	49.	47.
5	TOT		8032.	956.	414.	190.	210.	23.1	6.9	7854.	7382.	91.	86.	8.925	100.	95.	66.	63.
TOTAL			73862.	14276.	3001.	1552.	1927.	485.6	146.3	76083.	66275.	78.	69.	9.591	88.	79.	59.	53.

SYSTEM 2 - 2 LIGHT= 6 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	21	21	21	99.5	108.2	639647.	56.	56.	56.	59.	1.99	1.00	0.28	1.55
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	21	98.8	42.9	2797042.	0.	0.	56.	59.	1.97	1.00	0.28	1.53
2	6	21	21	21	99.5	105.8	650260.	56.	56.	56.	60.	1.99	1.00	0.28	1.55
2	10	21	21	6	99.2	68.4	65427.	56.	56.	1029.	41.	1.99	1.00	0.55	1.60
2	17	0	0	21	98.8	[illegible]	2797042.	0.	0.	56.	59.	1.97	1.00	0.28	1.53
3	6	21	6	6	96.3	13.4	58926.	56.	1029.	1029.	11.	1.47	1.00	0.84	1.29
3	10	21	21	6	99.2	66.7	67119.	56.	56.	1029.	42.	1.99	1.00	0.55	1.60
3	17	0	0	21	98.8	42.9	2797042.	0.	0.	56.	59.	1.97	1.00	0.28	1.53
4	6	21	21	21	99.3	81.0	793285.	56.	56.	56.	74.	1.99	1.00	0.28	1.55
4	10	21	21	6	99.0	53.5	83662.	56.	56.	1029.	54.	1.99	1.00	0.50	1.59
4	17	0	0	21	98.8	42.9	2797042.	0.	0.	56.	59.	1.97	1.00	0.28	1.53
5	6	21	21	6	99.1	55.9	315720.	56.	56.	1029.	54.	1.99	1.00	0.39	1.57
5	10	21	21	6	98.7	37.8	118540.	56.	56.	1029.	79.	1.95	1.00	0.46	1.55
5	17	0	0	21	98.8	42.9	2797042.	0.	0.	56.	59.	1.97	1.00	0.28	1.53

SYSTEM 2 - 2 LIGHT= 6 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

	AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES AREA (1000 SQ FT)			WEIGHT (TONS)				TRANSPORTATION COSTS ($1000) ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1 6	0.	0.	406.	0.	0.	296.	296.	68.	19.	60.	5.	17.3	5.2	146.	30.
1 10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1 17	0.	0.	405.	0.	0.	295.	295.	67.	19.	60.	5.	17.2	5.2	145.	30.
1 TOT	0.	0.	26485.	0.	0.	19305.	19305.	4442.	1279.	3938.	345.	1092.8	329.2	9473.	1953.
2 6	0.	0.	413.	0.	0.	301.	301.	99.	28.	151.	6.	4.4	1.3	255.	36.
2 10	617.	0.	248.	105.	0.	181.	286.	95.	27.	144.	6.	2.7	0.8	242.	34.
2 17	0.	0.	405.	0.	0	295.	295.	97.	28.	148.	6.	4.3	1.3	250.	35.
2 TOT	1234.	0.	18777.	210.	0.	13686.	13897.	4606.	1332.	6991.	293.	200.4	60.3	11799.	1685.
3 6	361.	0.	61.	61.	0.	44.	106.	35.	10.	76.	2.	1.1	0.3	113.	13.
3 10	621.	0.	256.	106.	0.	187.	293.	97.	28.	211.	8.	2.1	0.6	311.	36.
3 17	0.	0.	405.	0.	0.	295.	295.	97.	28.	213.	8.	3.2	0.9	314.	37.
3 TOT	1705.	0.	5706.	291.	0.	4159.	4450.	1475.	426.	3215.	124.	47.7	14.3	4738.	565.
4 6	0.	0.	504.	0.	0.	367.	367.	84.	24.	118.	34.	4.0	1.2	206.	59.
4 10	667.	0.	333.	114.	0.	243.	357.	82.	23.	114.	33.	2.6	0.7	199.	57.
4 17	0.	0.	405.	0.	0.	295.	295.	67.	19.	94.	27.	3.2	0.9	166.	48.
4 TOT	667.	0.	25035.	114.	0.	18248.	18362.	4225.	1216.	5899.	1712.	200.1	60.2	10325.	2989.
5 6	324.	0.	354.	55.	0.	253.	313.	18.	4.	97.	45.	3.4	1.0	119.	51.
5 10	765.	0.	496.	130.	0.	361.	492.	28.	7.	153.	71.	3.6	1.0	185.	80.
5 17	0.	0.	405.	0.	0.	295.	295.	17.	4.	91.	43.	3.2	0.9	112.	48.
5 TOT	1737.	0.	6825.	296.	0.	4974.	5271.	308.	81.	1642.	770.	56.0	16.8	2006.	868.
TOTAL	5345.	0.	82830.	913.	0.	60374.	61287.	15058.	4337.	21687.	3245.	1597.2	481.2	38342.	8063.

SYSTEM 2 - 2 LIGHT= 6 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

- - - - - - - - - - - - - - SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000) - - - - - - - - - - - - - - -

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	882.	146.	30.	26.	17.	15.6	4.7	909.	816.	178.	144.	0.058	178.	144.	114.	92.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	878.	145.	30.	25.	17.	15.5	4.6	905.	813.	177.	144.	3.127	180.	147.	117.	95.
1	TOT		57450.	9473.	1953.	1707.	1172.	983.5	296.3	59239.	53159.	186.	151.	2.402	188.	154.	122.	100.
2	6	98.	897.	255.	36.	26.	18.	3.9	1.1	1033.	839.	168.	140.	0.060	168.	140.	107.	90.
2	10	420.	900.	242.	34.	25.	24.	2.5	0.7	1025.	840.	170.	146.	0.536	170.	146.	106.	91.
2	17	5400.	878.	250.	35.	25.	17.	3.8	1.1	1012.	821.	164.	137.	3.127	167.	140.	109.	91.
2	TOT		41451.	11799.	1685.	1223.	853.	180.4	54.3	47738.	38762.	165.	138.	2.625	167.	141.	108.	91.
3	6	98.	343.	113.	13.	7.	9.	1.0	0.3	410.	321.	65.	53.	0.252	65.	53.	50.	41.
3	10	420.	920.	311.	36.	26.	25.	1.9	0.5	1106.	860.	179.	149.	0.546	179.	149.	111.	93.
3	17	5400.	878.	314.	37.	25.	17.	2.9	0.8	1070.	823.	169.	137.	3.127	172.	140.	112.	91.
3	TOT		13375.	4738.	565.	387.	284.	42.9	12.9	16[illegible]55.	12530.	151.	123.	2.468	153.	125.	101.	82.
4	6	98.	1094.	206.	59.	32.	22.	3.6	1.0	1167.	1037.	192.	173.	0.075	192.	173.	123.	111.
4	10	420.	1114.	199.	57.	32.	30.	2.3	0.7	1180.	1053.	200.	182.	0.646	201.	183.	126.	115.
4	17	5400.	878.	166.	48.	25.	17.	2.9	0.8	937.	833.	154.	138.	3.127	157.	141.	102.	92.
4	TOT		54697.	10325.	2989.	1619.	1117.	180.0	54.2	58331.	51854.	157.	141.	2.886	160.	144.	104.	93.
5	6	98.	958.	119.	51.	27.	22.	3.0	0.9	966.	908.	164.	153.	0.107	164.	153.	104.	97.
5	10	420.	1523.	185.	80.	47.	42.	3.2	0.9	1534.	1442.	267.	252.	0.858	268.	253.	172.	162.
5	17	5400.	878.	112.	48.	25.	17.	2.9	0.8	888.	833.	148.	138.	3.127	152.	141.	98.	92.
5	TOT		15821.	2006.	868.	468.	342.	50.4	15.1	15991.	15003.	158.	147.	2.461	161.	150.	104.	97.
TOTAL			182795.	38342.	8063.	5406.	3770.	1437.4	433.0	197556.	171309.	167.	142.	2.609	170.	145.	110.	94.

SYSTEM 2 - 3 LIGHT= 8 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	8	8	8	94.2	8.5	2658.	716.	716.	716.	4.	1.14	1.00	1.79	1.25
1	10	21	21	21	99.2	69.3	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
2	6	8	8	8	94.1	8.4	2703.	716.	716.	716.	4.	1.13	1.00	1.79	1.25
2	10	21	21	8	99.2	68.4	86388.	56.	56.	716.	43.	1.99	1.00	0.52	1.60
2	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
3	6	21	8	8	98.6	35.8	64378.	56.	716.	716.	13.	1.94	1.00	0.76	1.61
3	10	21	21	8	99.2	66.7	88241.	56.	56.	716.	45.	1.99	1.00	0.52	1.60
3	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
4	6	21	21	21	99.3	81.0	793285.	56.	56.	56.	74.	1.99	1.00	0.28	1.55
4	10	21	21	8	99.0	53.5	106356.	56.	56.	716.	56.	1.99	1.00	0.48	1.59
4	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
5	6	21	21	8	99.1	55.9	359798.	56.	56.	716.	56.	1.99	1.00	0.38	1.57
5	10	21	21	8	93.7	37.8	144547.	56.	56.	716.	82.	1.95	1.00	0.44	1.55
5	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58

SYSTEM 2 - 3 LIGHT= 8 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	408.	0.	0.	83.	0.	0.	83.	19.	5.	17.	1.	4.8	1.4	41.	8.
1	10	0.	0.	855.	0.	0.	622.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	423.	0.	0.	86.	0.	0.	86.	19.	5.	17.	1.	5.0	1.5	42.	8.
1	TOT	24818.	0.	2565.	5081.	0.	1869.	6951.	1599.	460.	1418.	124.	370.1	111.5	3387.	696.
2	6	415.	0.	0.	84.	0.	0.	84.	28.	8.	42.	1.	1.2	0.3	72.	10.
2	10	616.	0.	248.	126.	0.	181.	307.	101.	29.	154.	6.	2.9	0.9	259.	36.
2	17	423.	0.	0.	86.	0.	0.	86.	28.	8.	43.	1.	1.2	0.3	73.	10.
2	TOT	20251.	0.	497.	4146.	0.	362.	4509.	1494.	432.	2268.	95.	62.9	18.9	3826.	546.
3	6	361.	0.	61.	73.	0.	44.	118.	39.	11.	85.	3.	1.2	0.3	126.	15.
3	10	621.	0.	256.	127.	0.	187.	314.	104.	30.	227.	8.	2.2	0.6	333.	39.
3	17	423.	0.	0.	86.	0.	0.	86.	28.	8.	62.	2.	0.9	0.2	92.	11.
3	TOT	7213.	0.	440.	1476.	0.	320.	1797.	595.	172.	1298.	50.	18.5	5.5	1913.	228.
4	6	0.	0.	504.	0.	0.	367.	367.	84.	24.	118.	34.	4.0	1.2	206.	59.
4	10	667.	0.	333.	136.	0.	243.	379.	87.	25.	122.	35.	2.7	0.8	212.	61.
4	17	423.	0.	0.	86.	0.	0.	86.	19.	5.	27.	8.	0.9	0.2	48.	14.
4	TOT	24400.	0.	2351.	4995.	0.	1714.	6710.	1543.	444.	2155.	625.	72.2	21.7	3772.	1092.
5	6	324.	0.	354.	66.	0.	258.	324.	18.	5.	101.	47.	3.5	1.0	123.	53.
5	10	764.	0.	496.	156.	0.	361.	518.	30.	8.	161.	75.	3.7	1.1	195.	84.
5	17	423.	0.	0.	86.	0.	0.	86.	5.	1.	27.	12.	0.9	0.2	33.	14.
5	TOT	7246.	0.	1559.	1483.	0.	1136.	2620.	153.	40.	816.	382.	26.8	3.0	996.	431.
TOTAL		83932.	0.	7414.	17184.	0.	5404.	22588.	5387.	1550.	7957.	1278.	550.7	165.9	13895.	2994.

SYSTEM 2 - 3 LIGHT= 8 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	278.	41.	8.	4.	7.	4.4	1.3	282.	255.	54.	45.	0.300	54.	45.	43.	36
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	288.	42.	8.	4.	7.	4.5	1.3	282.	254.	66.	56.	7.769	74.	64.	46.	40.
1	TOT		22470.	3387.	696.	460.	588.	333.1	100.3	22385.	20196.	78.	66.	5.968	84.	72.	55.	47.
2	6	98.	282.	72.	10.	5.	8.	1.1	0.3	317.	262.	51.	44.	0.306	52.	44.	41.	35.
2	10	420.	959.	259.	36.	26.	25.	2.6	0.8	1094.	895.	180.	154.	0.434	180.	154.	112.	96.
2	17	5400.	288.	73.	10.	4.	7.	1.1	0.3	313.	257.	62.	54.	7.769	70.	62.	44.	39.
2	TOT		14875.	3826.	546.	272.	409.	56.6	17.0	16318.	13406.	66.	57.	6.504	72.	64.	47.	41.
3	6	98.	378.	126.	15.	8.	9.	1.1	0.3	452.	353.	71.	58.	0.109	71.	58.	44.	36.
3	10	420.	980.	333.	39.	27.	26.	2.0	0.6	1180.	916.	189.	157.	0.442	189.	157.	118.	98.
3	17	5400.	288.	92.	11.	4.	7.	0.8	0.2	330.	257.	64.	54.	7.769	71.	62.	45.	39.
3	TOT		5868.	1913.	228.	115.	158.	15.7	5.0	6836.	5331.	72.	61.	5.986	78.	67.	49.	42.
4	6	98.	1094.	206.	59.	32.	22.	3.6	1.0	1167.	1037.	192.	173.	0.075	192.	173.	123.	111.
4	10	420.	1178.	212.	61.	33.	32.	2.5	0.7	1249.	1115.	210.	191.	0.528	210.	192.	132.	120.
4	17	5400.	288.	48.	14.	4.	7.	0.8	0.2	291.	260.	59	55.	7.769	67.	62.	42.	39.
4	TOT		21723.	3772.	1092.	437.	565.	64.9	19.5	22234.	19867.	70.	65.	7.146	78.	72.	49.	45.
5	6	98.	989.	123.	53.	28.	23.	3.2	0.9	998.	937.	169.	157.	0.106	169.	157.	107.	100.
5	10	420.	1597.	195.	84.	48.	43.	3.4	1.0	1609.	1512.	278.	262.	0.707	279.	263.	179.	169.
5	17	5400.	288.	33.	14.	4.	7.	0.8	0.2	277.	260.	58.	55.	7.769	65.	62.	41.	39.
5	TOT		8318.	996.	431.	195.	217.	24.1	7.2	8209.	7717.	90.	85.	6.001	96.	91.	61.	58.
TOTAL			73256.	13895.	2994.	1481.	1938.	495.6	149.3	75984.	66519.	73.	65.	6.448	80.	71.	51.	46.

SYSTEM 2 - 4 LIGHT=10 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	10	10	10	95.6	11.1	6189.	493.	493.	493.	6.	1.34	1.00	1.23	1.28
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.23	1.69
2	6	10	10	10	95.5	11.0	6292.	493.	493.	493.	6.	1.32	1.00	1.23	1.27
2	10	21	21	10	99.2	68.4	135220.	56.	56.	493.	47.	1.99	1.00	0.49	1.59
2	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.23	1.69
3	6	21	10	10	99.1	60.2	77081.	56.	493.	493.	15.	1.99	1.00	0.66	1.62
3	10	21	21	10	99.2	66.7	137447.	56.	56.	493.	48.	1.99	1.00	0.48	1.59
3	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.23	1.69
4	6	10	10	10	94.5	9.0	7676.	493.	493.	493.	8.	1.18	1.00	1.23	1.17
4	10	21	21	10	99.0	53.5	159223.	56.	56.	493.	60.	1.99	1.00	0.45	1.58
4	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.23	1.69
5	6	21	10	10	98.6	35.6	140503.	56.	493.	493.	26.	1.94	1.00	0.61	1.58
5	10	21	21	10	98.7	37.8	205136.	56.	56.	493.	86.	1.95	1.00	0.42	1.55
5	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.23	1.69

SYSTEM 2 - 4 LIGHT=10 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	407.	0.	0.	100.	0.	0.	100.	23.	6.	20.	1.	5.8	1.7	49.	10.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	413.	0.	0.	101.	0.	0.	101.	23.	6.	20.	1.	5.9	1.7	50.	10.
1	TOT	24303.	0.	2565.	5995.	0.	1869.	7865.	1809.	571.	1604.	140.	423.6	127.6	3838.	789.
2	6	414.	0.	0.	102.	0.	0.	102.	33.	9.	51.	2.	1.4	0.4	86.	12.
2	10	616.	0.	248.	152.	0.	181.	333.	110.	31.	167.	7.	3.2	0.9	281.	39.
2	17	413.	0.	0.	101.	0.	0.	101.	33.	9.	51.	2.	1.4	0.4	86.	12.
2	TOT	19827.	0.	497.	4891.	0.	362.	5254.	1741.	503.	2643.	110.	73.5	22.1	4458.	636.
3	6	360.	0.	61.	89.	0.	44.	133.	44.	12.	96.	3.	1.4	0.4	142.	16.
3	10	621.	0.	256.	153.	0.	187.	340.	112.	32.	245.	9.	2.4	0.7	361.	42.
3	17	413.	0.	0.	101.	0.	0.	101.	33.	9.	73.	2.	1.1	0.3	108.	12.
3	TOT	7073.	0.	440.	1745.	0.	320.	2065.	684.	198.	1492.	57.	21.4	6.4	2198.	262.
4	6	505.	0.	0.	124.	0.	0.	124.	28.	8.	40.	11.	1.3	0.4	70.	20.
4	10	667.	0.	333.	164.	0.	243.	407.	93.	27.	131.	38.	2.9	0.8	227.	65.
4	17	413.	0.	0.	101.	0.	0.	101.	23.	6.	32.	9.	1.1	0.3	57.	16.
4	TOT	25820.	0.	333.	6369.	0.	24[illegible].	6613.	1521.	438.	2124.	616.	71.0	21.4	3717.	1076.
5	6	560.	0.	118.	138.	0.	86.	224.	13.	3.	69.	32.	2.4	0.7	85.	36.
5	10	764.	0.	496.	188.	0.	361.	550.	32.	8.	171.	80.	4.0	1.2	207.	90.
5	17	413.	0.	0.	101.	0.	0.	101.	5.	1.	31.	14.	1.1	0.3	38.	16.
5	TOT	7816.	0.	850.	1928.	0.	619.	2548.	149.	39.	793.	372.	25.9	7.8	968.	419.
TOTAL		84842.	0.	4687.	20930.	0.	3416.	24347.	5907.	1700.	8659.	1298.	615.6	185.4	15182.	3184.

SYSTEM 2 - 4   LIGHT=10   MEDIUM= 0   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

- - - - - - - - - - - - - - - - SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000) - - - - - - - - - - - - - - - -

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	326.	49.	10.	5.	8.	5.2	1.5	332.	300.	63.	51.	0.263	63.	52.	49.	40.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	330.	50.	10.	5.	8.	5.3	1.6	331.	299.	69.	57.	3.899	72.	61.	43.	36.
1	TOT		25014.	3838.	789.	508.	639.	381.3	114.8	25306.	22829.	81.	68.	3.027	84.	71.	53.	44.
2	6	98.	331.	86.	12.	5.	8.	1.3	0.4	374.	308.	59.	50.	0.268	60.	50.	47.	39.
2	10	420.	1033.	281.	39.	27.	27.	2.9	0.8	1180.	964.	192.	164.	0.427	192.	164.	120.	103.
2	17	5400.	330.	86.	12.	5.	8.	1.3	0.4	368.	302.	64.	55.	3.899	68.	59.	40.	35.
2	TOT		16948.	4458.	636.	311.	450.	66.2	19.9	18969.	15576.	69.	59.	3.288	72.	62.	44.	38.
3	6	98.	421.	142.	16.	9.	10.	1.3	0.3	505.	394.	78.	64.	0.078	78.	64.	48.	39.
3	10	420.	1054.	361.	42.	28.	27.	2.2	0.6	1271.	986.	202.	167.	0.436	202.	167.	127.	105.
3	17	5400.	330.	108.	12.	5.	8.	1.0	0.3	388.	303.	66.	55.	3.899	70.	59.	41.	34.
3	TOT		6616.	2198.	262.	129.	173.	19.2	5.8	7837.	6108.	76.	63.	3.021	79.	66.	47.	39.
4	6	98.	404.	70.	20.	7.	11.	1.2	0.3	425.	381.	69.	62.	0.336	69.	62.	59.	53.
4	10	420.	1258.	227.	65.	35.	33.	2.6	0.8	1334.	1190.	222.	202.	0.521	223.	203.	140.	128.
4	17	5400.	330.	57.	16.	5.	8.	1.0	0.3	342.	306.	61.	55.	3.899	64.	59.	38.	35.
4	TOT		21388.	3717.	1076.	383.	569.	63.9	19.2	22203.	19870.	64.	58.	3.610	67.	62.	41.	37.
5	6	98.	704.	85.	36.	16.	18.	2.2	0.6	708.	666.	119.	111.	0.131	119.	111.	75.	70.
5	10	420.	1688.	267.	[illegible]0.	49.	45.	3.6	1.0	1702.	1599.	292.	275.	0.701	293.	276.	188.	178.
5	17	5400.	330.	38.	16.	5.	8.	1.0	0.3	325.	306.	59.	55.	3.899	63.	59.	37.	35.
5	TOT		8100.	968.	419.	174.	216.	23.3	7.0	8062.	7584.	83.	78.	3.046	86.	81.	52.	49.
TOTAL			78067.	15182.	3184.	1508.	2049.	554.0	166.9	82380.	71969.	73.	63.	3.263	76.	67.	47.	41.

SYSTEM 2 - 5 LIGHT= 9 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

T	A	CLASS E	CLASS C	CLASS T	AVAILABILITY 0/0	AVAILABILITY SORTIES	S.L. SORTIES	PLACEMENT RATE E	PLACEMENT RATE C	PLACEMENT RATE T	PLACEMENT RATE SORTIES	NORMALIZED AVAIL	NORMALIZED S.L.	NORMALIZED P.R.	NORMALIZED EFFECT.
1	6	9	9	9	95.0	9.9	4063.	594.	594.	594.	5.	1.24	1.00	1.48	1.27
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.48	1.63
2	6	9	9	9	94.9	9.7	4130.	594.	594.	594.	5.	1.23	1.00	1.48	1.26
2	10	21	21	9	99.2	68.4	105807.	56.	56.	594.	45.	1.99	1.00	0.51	1.60
2	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	[illegible]	1.77	1.00	1.48	1.63
3	6	21	9	9	98.9	47.7	69430.	56.	594.	594.	[illegible]	[illegible].98	1.00	0.71	1.63
3	10	21	21	9	99.2	66.7	107808.	56.	56.	594.	[illegible]	[illegible].99	1.00	0.50	1.59
3	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.48	1.63
4	6	9	9	9	93.9	8.1	5038.	594.	594.	594.	7.	1.10	1.00	1.48	1.17
4	10	21	21	9	99.0	53.5	127379.	56.	56.	594.	58.	1.99	1.00	0.47	1.58
4	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.48	1.63
5	6	21	9	9	98.2	28.3	128622.	56.	594.	594.	25.	1.87	1.00	0.65	1.54
5	10	21	21	9	98.7	37.8	168641.	56.	56.	594.	83.	1.95	1.00	0.43	1.55
5	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.48	1.63

SYSTEM 2 - 5 LIGHT= 9 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)								
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	407.	0.	0.	91.	0.	0.	91.	21.	6.	18.	1.	5.3	1.6	45.	9.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	417.	0.	0.	93.	0.	0.	93.	21.	6.	19.	1.	5.4	1.6	46.	9.
1	TOT	24506.	0.	2565.	5506.	0.	1869.	7376.	1697.	488.	1504.	131.	395.0	119.0	3596.	739.
2	6	414.	0.	0.	93.	0.	0.	93.	30.	8.	46.	1.	1.3	0.4	79.	11.
2	10	616.	0.	248.	138.	0.	181.	319.	106.	30.	160.	6.	3.1	0.9	270.	38.
2	17	417.	0.	0.	93.	0.	0.	93.	31.	8.	47.	1.	1.3	0.4	79.	11.
2	TOT	19995.	0.	497.	4492.	0.	362.	4855.	1609.	465.	2442.	102.	67.8	20.4	4120.	588.
3	6	360.	0.	61.	81.	0.	44.	125.	41.	12.	90.	3.	1.3	0.4	133.	15.
3	10	621.	0.	256.	139.	0.	187.	326.	108.	31.	236.	9.	2.3	0.7	346.	41.
3	17	417.	0.	0.	93.	0.	0.	93.	31.	8.	67.	2.	1.0	0.3	99.	11.
3	TOT	7129.	0.	440.	1601.	0.	320.	1922.	637.	184.	1388.	53.	19.8	5.9	2046.	244.
4	6	505.	0.	0.	113.	0.	0.	113.	26.	7.	36.	10.	1.2	0.3	63.	18.
4	10	667.	0.	333.	149.	0.	243.	393.	90.	26.	126.	36.	2.8	0.8	219.	63.
4	17	417.	0.	0.	93.	0.	0.	93.	21.	6.	30.	8.	1.0	0.3	52.	15.
4	TOT	26058.	0.	333.	5854.	0.	243.	6098.	1403.	404.	1959.	568.	65.4	19.7	3428.	992.
5	6	560.	0.	118.	125.	0.	86.	212.	12.	3.	66.	30.	2.3	0.7	80.	34.
5	10	764.	0.	496.	171.	0.	361.	533.	31.	8.	166.	77.	3.9	1.1	201.	87.
5	17	417.	0.	0.	93.	0.	0.	93.	5.	1.	29.	13.	1.0	0.3	35.	15.
5	TOT	7871.	0.	850.	1768.	0.	619.	2388.	139.	37.	744.	348.	24.2	7.3	908.	393.
TOTAL		85560.	0.	4687.	19224.	0.	3416.	22641.	5487.	1579.	8039.	1205.	572.5	172.4	14099.	2958.

SYSTEM 2 - 5   LIGHT= 9   MEDIUM= 0   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

- - - - - - - - - - - - - - - - SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000) - - - - - - - - - - - - - - - -

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	300.	45.	9.	5.	8.	4.8	1.4	305.	277.	58.	48.	0.279	58.	48.	46.	38.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	307.	46.	9.	5.	8.	4.9	1.4	305.	276.	67.	56.	5.316	72.	62.	44.	38.
1	TOT		23645.	3596.	739.	482.	612.	355.5	107.1	23770.	21447.	79	66.	4.483	83.	71.	53.	45.
2	6	98.	305.	79.	11.	5.	8.	1.2	0.3	344.	284.	55	47.	0.284	55.	47.	44.	37.
2	10	420.	994.	270.	38.	26.	26.	2.8	0.8	1135.	928.	186.	158.	0.430	186.	159.	116.	99.
2	17	5400.	307.	79.	11.	5.	8.	1.2	0.3	339.	278.	62.	54.	5.816	68.	60.	41.	36.
2	TOT		15832.	4120.	588.	290.	428.	61.1	18.4	17573.	14437.	67.	57.	4.880	72.	62.	45.	39.
3	6	98.	398.	133.	15.	8.	10.	1.2	0.3	478.	372.	74.	61.	0.090	74.	61.	45.	37.
3	10	420.	1015.	346.	41.	27.	27.	2.1	0.6	1223.	949.	195.	162.	0.439	196.	162.	122.	101.
3	17	5400.	307.	99.	11.	5.	8.	0.9	0.2	357.	279.	64.	54.	5.816	70.	60.	42.	36.
3	TOT		6214.	2046.	244.	121.	165.	17.9	5.3	7310.	5700.	73.	61.	4.489	73.	66.	48.	40.
4	6	98.	372.	63.	18.	6.	10.	1.1	0.3	391.	351.	64.	58.	0.352	64.	58.	55.	49.
4	10	420.	1216.	219.	63.	34.	32.	2.5	0.7	1289.	1150.	216.	196.	0.524	216.	197.	136.	124.
4	17	5400.	307.	52.	15.	5.	8.	0.9	0.2	315.	282.	59.	54.	5.816	65.	60.	39.	36.
4	TOT		19950.	3428.	992.	355.	541.	58.9	17.7	20521.	18370.	62.	57.	5.371	67.	62.	42.	39.
5	6	98.	669.	80.	34.	16.	18.	2.0	0.6	673.	633.	113.	106.	0.152	114.	106.	73.	68.
5	10	420.	1640.	201.	87.	48.	44.	3.5	1.0	1653.	1553.	285.	269.	0.704	286.	269.	184.	173.
5	17	5400.	307.	35.	15.	5.	8.	0.9	0.2	300.	282.	57.	54.	5.816	63.	60.	38.	36.
5	TOT		7652.	908.	393.	166.	207.	21.8	6.5	7575.	7127.	81.	76.	4.515	85.	80.	53.	50.
TOTAL			73296.	14099.	2958.	1415.	1955.	515.2	155.2	76750.	67083.	71.	62.	4.843	76.	67.	47.	42.

SYSTEM 2 - 6   LIGHT= 7 MEDIUM= 0 HEAVY=17   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

T	A	CLASS E	CLASS C	CLASS T	AVAILABILITY 0/0	AVAILABILITY SORTIES	S.L. SORTIES	PLACEMENT RATE E	PLACEMENT RATE C	PLACEMENT RATE T	PLACEMENT RATE SORTIES	NORMALIZED AVAIL	NORMALIZED S.L.	NORMALIZED P.R.	NORMALIZED EFFECT.
1	6	7	7	7	93.1	7.1	1742.	860.	860.	860.	3.	1.01	1.00	2.15	1.24
1	10	17	17	17	97.5	19.9	62276.	126.	126.	126.	56.	1.72	1.00	0.63	1.43
1	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
2	6	17	17	17	99.3	75.0	120425.	126.	126.	126.	27.	1.99	1.00	0.63	1.62
2	10	17	17	7	97.4	19.5	33287.	126.	126.	860.	22.	1.71	1.00	1.03	1.50
2	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
3	6	17	7	7	96.4	13.6	16419.	126.	860.	860.	7.	1.48	1.00	1.33	1.40
3	10	17	17	7	97.4	19.0	33762.	126.	126.	860.	22.	1.69	1.00	1.03	1.49
3	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
4	6	17	17	17	99.1	59.8	146912.	126.	126.	126.	33.	1.99	1.00	0.63	1.62
4	10	17	17	7	96.7	15.2	38414.	126.	126.	860.	28.	1.55	1.00	0.97	1.38
4	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
5	6	17	17	7	98.8	43.1	102987.	126.	126.	860.	26.	1.97	1.00	0.81	1.64
5	10	17	17	7	95.4	10.8	48220.	126.	126.	860.	40.	1.31	1.00	0.91	1.20
5	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46

SYSTEM 2 - 5   LIGHT= 7 MEDIUM= 0 HEAVY=17   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($ 1000)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	409.	0.	0.	76.	0.	0.	76.	17.	5.	15.	1.	4.4	1.3	37.	7.
1	10	0.	0.	855.	0.	0.	416.	416.	55.	27.	85.	7.	16.2	4.8	197.	39.
1	17	433.	0	0.	81.	0.	0.	81.	18.	5.	16.	1.	4.7	1.4	39.	8.
1	TOT	25292.	0.	2556.	4726.	0.	1250.	5976.	1375.	396.	1219.	106.	325.2	97.9	2919.	600.
2	6	0.	0.	413.	0.	0.	201.	201.	66.	19.	101.	4.	2.9	0.8	171.	24.
2	10	616.	0.	249.	115.	0.	121.	236.	78.	22.	119.	4.	2.3	0.6	199.	28.
2	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	40.	1.	1.1	0.3	68.	9.
2	TOT	18147.	0.	2980.	3390.	0.	1452.	4843.	1605.	464.	2436.	102.	68.5	20.6	4110.	587.
3	6	361.	0.	61.	67.	0.	29.	97.	32.	9.	70.	2.	1.0	0.3	103.	12.
3	10	621.	0.	257.	116.	0.	125.	241.	80.	23.	174.	6.	1.7	0.5	256.	30.
3	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	58.	2.	0.8	0.2	86.	10.
3	TOT	7342.	0.	440.	1372.	0.	214.	1586.	526.	152.	1146.	44.	16.5	4.9	1688.	201.
4	6	0.	0.	504.	0.	0.	245.	245.	56.	16.	78.	22.	2.6	0.8	138.	40.
4	10	667.	0.	334.	124.	0.	162.	287.	66.	19.	92.	26.	2.1	0.6	160.	46.
4	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	26.	7.	0.8	0.2	45.	13.
4	TOT	24354.	0.	2352.	4662.	0.	1146.	5809.	1336.	384.	1866.	541.	62.6	18.8	3265.	945.
5	6	324.	0.	354.	60.	0.	172.	233.	13.	3.	72.	34.	2.5	0.7	88.	38.
5	10	765.	0.	496.	142.	0.	241.	384.	22.	5.	119.	56.	2.8	0.6	145.	63.
5	17	433.	0.	0.	81.	0.	0.	81.	4.	1.	25.	11.	0.8	0.2	30.	13.
5	TOT	7375.	0.	1559.	1378.	0.	759.	2138.	125.	33.	666.	312.	22.0	6.6	813.	352.
TOTAL		83114.	0.	9899.	15530.	0.	4823.	20353.	4968.	1430.	7334.	1107.	494.9	149.1	12797.	2687.

SYSTEM 2 - 6 LIGHT= 7 MEDIUM= 0 HEAVY=17 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	FIXED MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	257.	37.	7.	4.	7.	4.0	1.2	260.	236.	51.	42.	0.330	51.	42.	41.	34.
1	10	420.	1268.	197.	39.	31.	31.	14.6	4.4	1304.	1172.	238.	202.	0.891	239.	203.	167.	142.
1	17	5400.	273.	39.	8.	4.	7.	4.2	1.2	261.	235.	68.	59.	11.591	79.	70.	54.	48.
1	TOT		19751.	2919.	600.	362.	538.	292.7	88.1	19328.	17445.	73.	62.	8.894	82.	71.	57.	50.
2	6	98.	613.	171.	24.	13.	13.	2.6	0.7	703.	573.	111.	92.	0.068	111.	92.	68.	57.
2	10	420.	758.	199.	28.	18.	22.	2.0	0.6	859.	706.	141.	121.	0.925	142.	122.	94.	81.
2	17	5400.	273.	68.	9.	4.	7.	1.0	0.3	290.	238	64.	57.	11.591	76.	68.	52.	47.
2	TOT		15860.	4110.	587.	295.	421.	61.6	18.5	17274.	14146.	73.	64.	9.666	83.	74.	56.	49.
3	6	98.	318.	103.	12.	6.	8.	0.9	0.2	378.	297.	59.	48.	0.250	59.	49.	42.	34.
3	10	420.	773.	256.	30.	18.	23.	1.5	0.4	924.	721.	148.	124.	0.946	149.	125.	100.	83.
3	17	5400.	273.	86.	10.	4.	7.	0.8	0.2	306.	238.	65.	57.	11.591	77.	68.	53.	47.
3	TOT		5282.	1688.	201.	96.	147.	14.8	4.4	6046.	4718.	69.	59.	8.964	78.	68.	53.	47.
4	6	98.	748.	138.	40.	17.	17.	2.4	0.7	795.	708.	127.	114.	0.085	127.	114.	78.	70.
4	10	420.	916.	160.	46.	22.	27.	1.8	0.5	966.	865.	163.	149.	1.150	164.	150.	118.	108.
4	17	5400.	273.	45.	13.	4.	7.	0.8	0.2	270.	241.	61.	57.	11.591	73.	69.	50.	47.
4	TOT		19221.	3265.	945.	346.	518.	56.3	16.9	19268.	17213.	67.	62.	10.666	73.	73.	53.	49.
5	6	98.	729.	88.	38.	16.	19.	2.3	0.6	734.	690.	122.	114.	0.119	122.	114.	74.	69.
5	10	420.	1218.	145.	63.	32.	37.	2.5	0.7	1224.	1151.	212.	200.	1.579	214.	202.	178.	168.
5	17	5400.	273.	30.	13.	4.	7.	0.8	0.2	256.	241.	60.	57.	11.591	72.	69.	49.	47.
5	TOT		6963.	813.	352.	141.	193.	19.8	5.9	6765.	6364.	80.	76.	8.978	89.	84.	61.	58.
TOTAL			67079.	12797.	2687.	1243.	1820.	445.4	134.2	68683.	59895.	72.	64.	9.614	81.	73.	55.	50.

SYSTEM 2 - 7 LIGHT=10 MEDIUM= 0 HEAVY=17 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	10	10	10	95.6	11.1	6189.	493.	493.	493.	6.	1.34	1.00	1.23	1.28
1	10	17	17	17	97.5	19.9	62276.	126.	126.	126.	56.	1.72	1.00	0.63	1.43
1	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.23	1.69
2	6	10	10	10	95.5	11.0	6292.	493.	493.	493.	6.	1.32	1.00	1.23	1.27
2	10	17	17	10	97.4	19.5	94792.	126.	126.	493.	26.	1.71	1.00	0.86	1.47
2	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.23	1.69
3	6	17	10	10	98.6	37.0	32419.	126.	493.	493.	10.	1.94	1.00	0.99	1.66
3	10	17	17	10	97.4	19.0	95739.	126.	126.	493.	27.	1.69	1.00	0.86	1.45
3	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.23	1.69
4	6	10	10	10	94.5	9.0	7676.	493.	493.	493.	8.	1.18	1.00	1.23	1.17
4	10	17	17	10	96.7	15.2	105002.	126.	126.	493.	33.	1.55	1.00	0.83	1.35
4	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.23	1.69
5	6	17	10	10	97.7	21.7	54195.	126.	493.	493.	17.	1.76	1.00	0.96	1.52
5	10	17	17	10	95.4	10.8	124534.	126.	126.	493.	45.	1.31	1.00	0.80	1.18
5	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.23	1.69

SYSTEM 2 - 7   LIGHT=10   MEDIUM= 0   HEAVY=17   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							T R A N S P O R T A T I O N C O S T S ($ 1 0 0 0)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	407.	0.	0.	10[illegible]	0.	0.	100.	23.	6.	20.	1.	5.8	1.7	49.	10.
1	10	0.	0.	855.	0.	0.	416.	416.	95.	27.	85.	7.	16.2	4.8	197.	39.
1	17	413.	0.	0.	101.	0.	0.	101.	23.	6.	20.	1.	5.9	1.7	50.	10.
1	TOT	24303.	0.	2566.	5995.	0.	1250.	7246.	1667.	480.	1478.	129.	399.5	120.3	3545.	730.
2	6	414.	0.	0.	102.	0.	0.	102.	33.	9.	51.	2.	1.4	0.4	86.	12.
2	10	616.	0.	249.	152.	0.	121.	273.	90.	26.	137.	5.	2.6	0.8	230.	32.
2	17	413.	0.	0.	101.	0.	0.	101.	33.	9.	51.	2.	1.4	0.4	86.	12.
2	TOT	19827.	0.	498.	4891.	0.	243.	5134.	1702.	492.	2583.	108.	72.4	21.8	4357.	622.
3	6	360.	0.	61.	89.	0.	29.	118.	39.	11.	85.	3.	1.3	0.3	126.	15.
3	10	621.	0.	257.	153.	0.	125.	278.	92.	26.	201.	7.	2.0	0.6	295.	35.
3	17	413.	0.	0.	101.	0.	0.	101.	33.	9.	73.	2.	1.1	0.3	108.	12.
3	TOT	7073.	0.	440.	1745.	0.	214.	1959.	649.	187.	1415.	54.	20.4	6.1	2685.	248.
4	6	505.	0.	0.	124.	0.	0.	124.	28.	8.	40.	11.	1.3	0.4	70.	20.
4	10	667.	0.	334.	164.	0.	162.	327.	75.	21.	105.	30.	2.3	0.7	182.	52.
4	17	413.	0.	0.	101.	0.	0.	101.	23.	6.	32.	9.	1.1	0.3	57.	16.
4	TOT	25820.	0.	334.	6369.	0.	162.	6532.	1503.	432.	2098.	609.	70.4	21.2	3672.	1063.
5	6	560.	0.	118.	138.	0.	57.	195.	11.	3.	60.	28.	2.1	0.6	74.	32.
5	10	764.	0.	496.	188.	0.	241.	430.	25.	6.	134.	62.	3.1	0.9	162.	70.
5	17	413.	0.	0.	101.	0.	0.	101.	5.	1.	31.	14.	1.1	0.3	38.	16.
5	TOT	7816.	0.	851.	1928.	0.	414.	2342.	137.	36.	729.	342.	24.1	7.2	890.	385.
TOTAL		84842.	0.	4691.	20930.	0.	2285.	23216.	5659.	1629.	8305.	1244.	587.0	176.8	14552.	3050.

SYSTEM 2 - 7 LIGHT=10 MEDIUM= 0 HEAVY=17 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	326.	49.	10.	5.	8.	5.2	1.5	332.	300.	63.	51.	0.263	63.	52.	49.	40.
1	10	420.	1268.	197.	39.	31.	31.	14.6	4.4	1304.	1172.	238.	202.	0.891	239.	203.	167.	142.
1	17	5400.	330.	50.	10.	5.	8.	5.3	1.6	331.	299.	69.	57.	3.899	72.	61.	43.	36.
1	TOT		23257.	3545.	730.	428.	611.	359.5	108.3	23480.	21198.	76.	63.	3.050	79.	66.	50.	42.
2	6	98.	331.	86.	12.	5.	8.	1.3	0.4	374.	308.	59.	50.	0.268	60.	50.	47.	39.
2	10	420.	863.	230.	32.	19.	24.	2.4	0.7	981.	804.	159.	136.	0.914	160.	137.	109.	93.
2	17	5400.	330.	86.	12.	5.	8.	1.3	0.4	368.	302.	64.	55.	3.899	68.	59.	40.	35.
2	TOT		16608.	4357.	622.	296.	445.	65.1	19.6	18572.	15256.	68.	58.	3:309	71.	61.	44.	38.
3	6	98.	379.	126.	15.	7.	9.	1.1	0.3	454.	354.	70.	57.	0.107	70.	57.	42.	34.
3	10	420.	878.	295.	35.	20.	25.	1.8	0.5	1054.	820.	167.	138.	0.935	168.	139.	115.	95.
3	17	5400.	330.	108.	12.	5.	8.	1.0	0.3	388.	303.	66.	55.	3.899	70.	59.	41.	34.
3	TOT		6314.	2085.	248.	115.	168.	18.4	5.5	7465.	5825.	72.	60.	3.056	75.	63.	45.	38.
4	6	98.	404.	70.	20.	7.	11.	1.2	0.3	425.	381.	69.	62.	0.336	69.	62.	59.	53.
4	10	420.	1029.	182.	52.	24.	29.	2.1	0.6	1038.	972.	180.	164.	1.139	182.	166.	133.	122.
4	17	5400.	330.	57.	16.	5.	8.	1.0	0.3	342.	306.	61.	55.	3.899	64.	59.	38.	35.
4	TOT		21159.	3672.	1063.	372.	566.	63.4	19.1	21957.	19653.	63.	57.	3.620	67.	61.	41.	37.
5	6	98.	623.	74.	32.	13.	17.	1.9	0.5	626.	589.	104.	97.	0.184	104.	97.	68.	63.
5	10	420.	1348.	162.	70.	34.	40.	2.8	0.8	1356.	1275.	232.	219.	1.568	233.	220.	198.	186.
5	17	5400.	330.	38.	16.	5.	8.	1.0	0.3	325.	306.	59.	55.	3.899	63.	59.	37.	35.
5	TOT		7517.	890.	385.	147.	206.	21.7	6.5	7469.	7029.	77.	72.	3.106	80.	75.	52.	49.
TOTAL			74857.	14552.	3050.	1361.	1998.	528.3	159.1	78945.	68962.	70.	61.	3.285	73.	64.	46.	40.

SYSTEM 2 - 9 LIGHT=11 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	11	11	11	96.0	12.3	9442.	408.	408.	408.	8.	1.41	1.00	1.02	1.29
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.02	1.67
2	6	11	11	11	95.9	12.1	9598.	408.	408.	408.	8.	1.39	1.00	1.02	1.28
2	10	21	21	11	99.2	68.4	180198.	56.	56.	408.	49.	1.99	1.00	0.47	1.59
2	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.02	1.67
3	6	11	11	11	95.8	11.8	9794.	408.	408.	408.	8.	1.38	1.00	1.02	1.27
3	10	21	21	11	99.2	66.7	182770.	56.	56.	408.	50.	1.99	1.00	0.46	1.59
3	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.02	1.67
4	6	11	11	11	94.9	9.7	11710.	408.	408.	408.	10.	1.23	1.00	1.02	1.17
4	10	21	21	11	99.0	53.5	207920.	56.	56.	408.	62.	1.99	1.00	0.44	1.58
4	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.02	1.67
5	6	21	11	11	98.8	43.2	158672.	56.	408.	408.	28.	1.97	1.00	0.57	1.59
5	10	21	21	11	98.7	37.8	260944.	56.	56.	408.	88.	1.95	1.00	0.41	1.54
5	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.02	1.67

SYSTEM 2 - 9   LIGHT=11   MEDIUM= 0   HEAVY=21   OPIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							T R A N S P O R T A T I O N C O S T S ($ 1 0 0 0)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	407.	0.	0.	110.	0.	0.	110.	25.	7.	22.	1.	6.4	1.9	54.	11.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	410.	0.	0.	111.	0.	0.	111.	25.	7.	22.	1.	6.5	1.9	54.	11.
1	TOT	24170.	0.	2565.	6555.	0.	1869.	8425.	1938.	558.	1713.	150.	456.4	137.5	4113.	846.
2	6	413.	0.	0.	112.	0.	0.	112.	37.	10.	56.	2.	1.6	0.4	95.	13.
2	10	616.	0.	243.	167.	0.	181.	348.	115.	33.	175.	7.	3.3	1.0	294.	41.
2	17	410.	0.	0.	111.	0.	0.	111.	36.	10.	55.	2.	1.6	0.4	94.	13.
2	TOT	19717.	0.	497.	5348.	0.	362.	5711.	1893.	547.	2873.	120.	80.1	24.1	4846.	692.
3	6	422.	0.	0.	114.	0.	0.	114.	37.	10.	82.	3.	1.2	0.3	122.	14.
3	10	621.	0.	256.	168.	0.	187.	355.	117.	34.	256.	9.	2.6	0.7	377.	44.
3	17	410.	0.	0.	111.	0.	0.	111.	36.	10.	80.	3.	1.2	0.3	118.	14.
3	TOT	7222.	0.	256.	1958.	0.	187.	2146.	711.	205.	1550.	59.	22.2	6.7	2283.	272.
4	6	504.	0.	0.	136.	0.	0.	136.	31.	9.	44.	12.	1.5	0.4	77.	22.
4	10	667.	0.	333.	180.	0.	243.	424.	97.	28.	136.	39.	3.1	0.9	237.	68.
4	17	410.	0.	0.	111.	0.	0.	111.	25.	7.	35.	10.	1.2	0.3	62.	18.
4	TOT	25663.	0.	333.	6960.	0.	243.	7204.	1657.	477.	2314.	671.	77.4	23.3	4049.	1172.
5	6	560.	0.	118.	152.	0.	86.	238.	13.	3.	74.	34.	2.6	0.7	90.	39.
5	10	764.	0.	496.	207.	0.	361.	569.	33.	8.	177.	83.	4.1	1.2	214.	93.
5	17	410.	0.	0.	111.	0.	0.	111.	6.	1.	34.	16.	1.2	0.3	42.	18.
5	TOT	7779.	0.	850.	2110.	0.	619.	2730.	159.	42.	850.	398.	27.8	8.3	1038.	449.
TOTAL		84553.	0.	4504.	22933.	0.	3233.	2[illegible]216.	6360.	1831.	9307.	1401.	664.1	200.0	16332.	3433.

SYSTEM 2 - 9 LIGHT=11 MEDIUM= 0 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	354.	54.	11.	6.	9.	5.8	1.7	361.	326.	68.	55.	0.252	68.	56.	53.	43.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	356.	54.	11.	6.	9.	5.8	1.7	360.	325.	72.	59.	3.309	75.	63.	45.	37.
1	TOT		26591.	4113.	846.	541.	66[illegible]	410.7	123.7	27024.	24370.	8[illegible].	70.	2.577	88.	73.	55.	46.
2	6	98.	360.	95.	13.	6.	9.	1.4	0.4	408.	335.	64.	54.	0.257	64.	54.	50.	42.
2	10	420.	1076.	294.	41.	28.	28.	3.0	0.9	1230.	1004.	199.	170.	0.426	200.	170.	125.	107.
2	17	5400.	356.	94.	13.	6.	9.	1.4	0.4	400.	328.	67.	57.	3.309	71.	60.	42.	36.
2	TOT		18233.	4846.	692.	338.	474.	72.1	21.7	20535.	16847.	72.	61.	2.796	75.	64.	47.	40.
3	6	98.	367.	122.	14.	6.	9.	1.1	0.3	439.	343.	67.	55.	0.263	68.	55.	53.	43.
3	10	420.	1097.	377.	44.	29.	28.	2.3	0.7	1324.	1026.	210.	173.	0.434	210.	174.	132.	109.
3	17	5400.	356.	118.	14.	6.	9.	1.0	0.3	422.	329.	69.	57.	3.309	72.	60.	43.	36.
3	TOT		6839.	2283.	272.	129.	178.	20.0	5.0	8136.	6339.	77.	63.	2.602	79.	66.	50.	41.
4	6	93.	439.	77.	22.	8.	11.	1.3	0.4	462.	414.	74.	67.	0.325	75.	67.	64.	57.
4	10	420.	1304.	2[illegible]7.	68.	35.	34.	2.7	0.8	1384.	1234.	230.	209.	0.520	230.	210.	145.	132.
4	17	5400.	356.	62.	18.	6.	9.	1.0	0.3	372.	333.	63.	57.	3.309	67.	61.	40.	36.
4	TOT		23050.	4049.	1172.	417.	600.	69.7	21.0	24086.	21545.	67.	60.	3.067	70.	63.	43.	39.
5	6	98.	743.	90.	39.	17.	19.	2.3	0.7	748.	703.	125.	116.	0.118	125.	117.	78.	73.
5	10	420.	1741.	214.	93.	50.	46.	3.7	1.1	1756.	1649.	300.	283.	0.699	301.	284.	194.	183.
5	17	5400.	356.	42.	18.	6.	9.	1.0	0.3	354.	333.	61.	57.	3.309	65.	61.	38.	36.
5	TOT		8613.	1038.	449.	184.	225.	25.0	7.5	8606.	8094.	87.	81.	2.592	89.	84.	55.	51.
TOTAL			83327.	10332.	3433.	1612.	2147.	597.7	180.0	88389.	77197.	76.	66.	2.778	79.	68.	49.	43.

SYSTEM 3 - 1 LIGHT= 7 MEDIUM= 9 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	7	7	7	93.1	7.1	1742.	860.	860.	860.	3.	1.01	1.00	2.15	1.24
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
2	6	9	9	9	94.9	9.7	4130.	594.	594.	594.	5.	1.23	1.00	1.98	1.36
2	10	21	21	7	99.2	68.4	73715.	56.	56.	860.	42.	1.99	1.00	0.54	1.60
2	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
3	6	21	7	7	98.0	24.6	61081.	56.	860.	860.	12.	1.82	1.00	0.80	1.53
3	10	21	21	7	99.2	66.7	75470.	56.	56.	860.	43.	1.99	1.00	0.53	1.60
3	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
4	6	9	9	9	93.9	8.1	5038.	594.	594.	594.	7.	1.10	1.00	1.98	1.27
4	10	21	21	7	99.0	53.5	92635.	56.	56.	860.	55.	1.99	1.00	0.49	1.59
4	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
5	6	21	9	7	98.2	28.3	111576.	56.	594.	860.	23.	1.87	1.00	0.76	1.56
5	10	21	21	7	98.7	37.8	128822.	56.	56.	860.	80.	1.95	1.00	0.45	1.55
5	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46

SYSTEM 3 - 1 LIGHT= 7 MEDIUM= 9 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	409.	0.	0.	76.	0.	0.	76.	17.	5.	15.	1.	4.4	1.3	37.	7.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	16.	1.	4.7	1.4	39.	8.
1	TOT	25292.	0.	2565.	4726.	0.	1869.	6595.	1517.	437.	1345.	117.	349.3	105.2	3212.	660.
2	6	0.	414.	0.	0.	93.	0.	93.	30.	8.	46.	1.	1.3	0.4	79.	11.
2	10	616.	0.	248.	115.	0.	181.	296.	98.	28.	149.	6.	2.8	0.8	250.	35.
2	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	40.	1.	1.1	0.3	68.	9.
2	TOT	18147.	2487.	497.	3390.	558.	362.	4312.	1429.	413.	2169.	90.	60.1	18.1	3659.	522.
3	6	361.	0.	61.	67.	0.	44.	112.	37.	10.	80.	3.	1.2	0.3	119.	14.
3	10	621.	0.	256.	116.	0.	187.	303.	100.	29.	219.	8.	2.2	0.6	321.	38.
3	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	58.	2.	0.8	0.2	86.	10.
3	TOT	7342.	0.	440.	1372.	0.	320.	1692.	561.	162.	1222.	47.	17.4	5.2	1801.	214.
4	6	0.	505.	0.	0.	113.	0.	113.	26.	7.	36.	10.	1.2	0.3	63.	18.
4	10	667.	0.	333.	124.	0.	243.	368.	84.	24.	118.	34.	2.6	0.8	205.	53.
4	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	26.	7.	0.8	0.2	45.	13.
4	TOT	24954.	2021.	333.	4662.	454.	243.	5360.	1233.	355.	1722.	499.	57.4	17.3	3013.	872.
5	6	324.	236.	118.	60.	53.	86.	199.	11.	3.	62.	29.	2.1	0.6	76.	32.
5	10	765.	0.	496.	142.	0.	361.	504.	29.	7.	157.	73.	3.6	1.1	190.	82.
5	17	433.	0.	0.	81.	0.	0.	81.	4.	1.	25.	11.	0.8	0.2	30.	13.
5	TOT	7375.	709.	850.	1378.	159.	619.	2157.	126.	33.	672.	315.	21.8	6.5	820.	355.
TOTAL		83114.	5218.	4687.	15530.	1172.	3416.	20119.	4868.	1401.	7132.	1071.	506.3	152.5	12507.	2625.

SYSTEM 3 - 1   LIGHT= 7   MEDIUM= 9   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	257.	37.	7.	4.	7.	4.0	1.2	260.	236.	51.	42.	0.330	51.	42.	41.	34.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	273.	39.	8.	4.	7.	4.2	1.2	261.	235.	68.	59.	11.591	79.	70.	54.	48.
1	TOT		21509.	3212.	660.	442.	566.	314.4	94.7	21153.	19076.	78.	67.	8.871	87.	76.	60.	52.
2	6	98.	305.	79.	11.	5.	8.	1.2	0.3	344.	284.	55.	47.	0.284	55.	47.	40.	34.
2	10	420.	928.	250.	35.	25.	25.	2.6	0.7	1058.	866.	174.	149.	0.439	175.	150.	109.	93.
2	17	5400.	273.	68.	9.	4.	7.	1.0	0.3	290.	238.	64.	57.	11.591	76.	68.	52.	47.
2	TOT		14355.	3659.	522.	262.	395.	54.1	16.3	15519.	12734.	68.	59.	9.673	77.	69.	53.	47.
3	6	98.	360.	119.	14.	8.	9.	1.1	0.3	430.	336.	67.	55.	0.146	68.	55.	44.	36.
3	10	420.	948.	321.	38.	26.	25.	1.9	0.6	1141.	887.	184.	152.	0.447	184.	153.	114.	95.
3	17	5400.	273.	86.	10.	4.	7.	0.8	0.2	306.	238.	65.	57.	11.591	77.	68.	53.	47.
3	TOT		5584.	1801.	214.	110.	152.	15.7	4.7	6418.	5001.	73.	62.	8.916	82.	71.	55.	48.
4	6	98.	372.	63.	18.	[illegible]	10.	1.1	0.3	391.	351.	64.	58.	0.352	64.	58.	50.	46.
4	10	420.	1145.	205.	59.	33.	31.	2.4	0.7	1212.	1082.	205.	187.	0.532	205.	187.	129.	117.
4	17	5400.	273.	45.	13.	4.	7.	0.8	0.2	270.	241.	61.	57.	11.591	73.	69.	50.	47.
4	TOT		17948.	3013.	872.	316.	496.	51.7	15.5	17898.	16007.	64.	59.	10.673	75.	70.	51.	48.
5	6	98.	634.	76.	32.	15.	17.	1.9	0.5	637.	600.	108.	101.	0.153	108.	101.	69.	64.
5	10	420.	1558.	190.	82.	47.	43.	3.3	1.0	1570.	1475.	273.	257.	0.712	273.	258.	175.	165.
5	17	5400.	273.	30.	13.	4.	7.	0.8	0.2	256.	241.	60.	57.	11.591	72.	69.	49.	47.
5	TOT		7017.	820.	355.	154.	194.	19.6	5.9	6822.	6417.	81.	77.	8.933	90.	85.	60.	57.
TOTAL			66415.	12507.	2625.	1286.	1805.	455.6	137.2	67812.	59237.	71.	63.	9.604	81.	73.	55.	50.

SYSTEM 3 - 2 LIGHT= 7 MEDIUM= 8 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

T	A	CLASS E	CLASS C	CLASS T	AVAILABILITY 0/0	AVAILABILITY SORTIES	S.L. SORTIES	PLACEMENT RATE E	PLACEMENT RATE C	PLACEMENT RATE T	PLACEMENT RATE SORTIES	NORMALIZED AVAIL	NORMALIZED S.L.	NORMALIZED P.R.	EFFECT.
1	6	7	7	7	93.1	7.1	1742.	860.	860.	860.	3.	1.01	1.00	2.15	1.24
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
2	6	8	8	8	94.1	8.4	2703.	716.	716.	716.	4.	1.13	1.00	2.38	1.37
2	10	21	[illegible]	7	99.2	68.4	73715.	56.	56.	860.	42.	1.99	1.00	0.54	1.60
2	17	0	[illegible]	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
3	6	21	7	7	98.0	24.6	61081.	56.	860.	860.	12.	1.82	1.00	0.80	1.53
3	10	21	21	7	99.2	66.7	75470.	56.	56.	860.	43.	1.99	1.00	0.53	1.60
3	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
4	6	21	21	21	99.3	81.0	793285.	56.	56.	56.	74.	1.99	1.00	0.28	1.55
4	10	21	21	7	99.0	53.5	92635.	56.	56.	860.	55.	1.99	1.00	0.49	1.59
4	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
5	6	21	21	7	99.1	55.9	333148.	56.	56.	860.	55.	1.99	1.00	0.38	1.57
5	10	21	21	7	98.7	37.8	128822.	56.	56.	360.	80.	1.95	1.00	0.45	1.55
5	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46

SYSTEM 3 - 2 LIGHT= 7 MEDIUM= 8 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

T	A	AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES AREA (1000 SQ FT) LIGHT	MEDIUM	HEAVY	WEIGHT (TONS) LIGHT	MEDIUM	HEAVY	TOTAL	TRANSPORTATION COSTS ($1000) ORIGIN-PORT AIR	TRUCK	CONUS-COMMZ AIR	SHIP	COMMZ-FIELD AIR	TRUCK	TOTAL AIR	SURFACE
1	6	409.	0.	0.	76.	0.	0.	76.	17.	5.	15.	1.	4.4	1.3	37.	7.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	16.	1.	4.7	1.4	39.	8.
1	TOT	25292.	0.	2565.	4726.	0.	1869.	6595.	1517.	437.	1345.	117.	349.3	105.2	3212.	660.
2	6	0.	415.	0.	0.	84.	0.	84.	28.	8.	42.	1.	1.2	0.3	72.	10.
2	10	616.	0.	248.	115.	0.	181.	296.	98.	28.	149.	6.	2.8	0.8	250.	35.
2	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	40.	1.	1.1	0.3	68.	9.
2	TOT	18147.	2490.	497.	3390.	509.	362.	4263.	1413.	408.	2145.	89.	59.4	17.9	3617.	516.
3	6	361.	0.	61.	67.	0.	44.	112.	37.	10.	80.	3.	1.2	0.3	119.	14.
3	10	621.	0.	256.	116.	0.	187.	303.	100.	29.	219.	8.	2.2	0.6	321.	38.
3	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	58.	2.	0.8	0.2	86.	10.
3	TOT	7342.	0.	440.	1372.	0.	320.	1692.	561.	162.	1222.	47.	17.4	5.2	1801.	214.
4	6	0.	0.	504.	0.	0.	367.	367.	84.	24.	128.	34.	4.0	1.2	206.	59.
4	10	667.	0.	333.	124.	0.	243.	368.	84.	24.	118.	34.	2.6	0.8	205.	59.
4	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	26.	7.	0.8	0.2	45.	13.
4	TOT	24954.	0.	2351.	4662.	0.	1714.	6377.	1467.	422.	2043.	594.	68.6	20.6	3584.	1037.
5	6	324.	0.	354.	60.	0.	258.	318.	18.	4.	99.	46.	3.4	1.0	121.	52.
5	10	765.	0.	496.	142.	0.	361.	504.	29.	7.	157.	73.	3.6	1.1	190.	82.
5	17	433.	0.	0.	81.	0.	0.	81.	4.	1.	25.	11.	0.8	0.2	30.	13.
5	TOT	7375.	0.	1559.	1378.	0.	1136.	2514.	147.	39.	783.	367.	25.7	7.7	956.	414.
TOTAL		83114.	2490.	7414.	15530.	509.	5404.	21444.	5106.	1469.	7545.	1217.	520.6	156.8	13173.	2843.

SYSTEM 3 - 2 LIGHT= 7 MEDIUM= 8 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	257.	37.	7.	4.	7.	4.0	1.2	260.	236.	51.	42.	0.330	51.	42.	41.	34.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	273.	39.	8.	4.	7.	4.2	1.2	261.	235.	68.	59.	11.591	79.	70.	54.	48.
1	TOT		21509.	3212.	660.	442.	566.	314.4	94.7	21153.	19076.	78.	67.	8.871	87.	76.	60.	52.
2	6	98.	282.	72.	10.	5.	8.	1.1	0.3	317.	262.	51.	44.	0.306	52.	44.	37.	32.
2	10	420.	928.	250.	35.	25.	25.	2.6	0.7	1058.	866.	174.	149.	0.439	175.	150.	109.	93.
2	17	5400.	273.	68.	9.	4.	7.	1.0	0.3	290.	238.	64.	57.	11.591	76.	68.	52.	47.
2	TOT		14217.	3617.	516.	259.	393.	53.5	16.1	15356.	12602.	67.	59.	9.676	77.	69.	52.	47.
3	6	98.	360.	119.	14.	8.	9.	1.1	0.3	430.	336.	67.	55	0.146	68.	55.	44.	36.
3	10	420.	948.	321.	38.	26.	25.	1.9	0.6	1141.	887.	184.	152.	0.447	184.	153.	114.	95.
3	17	5400.	273.	86.	10.	4.	7.	0.8	0.2	306.	238.	65.	57.	11.591	77.	68.	53.	47.
3	TOT		5584.	1801.	214.	110.	152.	15.7	4.7	6418.	5001.	73.	62.	8.916	82.	71.	55.	48.
4	6	98.	1094.	206.	59.	32.	22.	3.6	1.0	1167.	1037.	192.	173.	0.075	192.	173.	123.	111.
4	10	420.	1145.	205.	59.	33.	31.	2.4	0.7	1212.	1082.	205.	187.	0.532	205.	187.	129.	117.
4	17	5400.	273.	45.	13.	4.	7.	0.8	0.2	270.	241.	61.	57.	11.591	73.	69.	50.	47.
4	TOT		20833.	3584.	1037.	420.	543.	61.7	18.6	21002.	18753.	72.	67.	10.655	83.	77.	56.	52.
5	6	98.	973.	121.	52.	27.	23.	3.1	0.9	981.	922.	166.	155.	0.107	166.	155.	106.	98.
5	10	420.	1558.	190.	82.	47.	43.	3.3	1.0	1570.	1475.	273.	257.	0.712	273.	258.	175.	165.
5	17	5400.	273.	30.	13.	4.	7.	0.8	0.2	256.	241.	60.	57.	11.591	72.	69.	49.	47.
5	TOT		8032.	956.	414.	190.	210.	23.1	6.9	7854.	7382.	91.	86.	8.925	100.	95.	66.	63.
TOTAL			70176.	13173.	2843.	1423.	1866.	468.5	141.1	71785.	62816.	75.	66.	9.598	84.	76.	57.	51.

SYSTEM 3 - 3 LIGHT= 7 MEDIUM=10 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	7	7	7	93.1	7.1	1742.	860.	860.	860.	3.	1.01	1.00	2.15	1.24
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
2	6	10	10	10	95.5	11.0	6292.	493.	493.	493.	6.	1.32	1.00	1.64	1.35
2	10	21	21	7	99.2	68.4	73715.	56.	56.	860.	42.	1.99	1.00	0.54	1.60
2	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
3	6	21	7	7	98.0	24.6	61081.	56.	860.	860.	12.	1.82	1.00	0.80	1.53
3	10	21	21	7	99.2	66.7	75470.	56.	56.	860.	43.	1.99	1.00	0.53	1.60
3	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
4	6	10	10	10	94.5	9.0	7676.	493.	493.	493.	8.	1.18	1.00	1.64	1.25
4	10	21	21	7	99	[illegible]	92635.	56.	56.	860.	55.	1.99	1.00	0.49	1.59
4	17	0	[illegible]	[illegible]	[illegible]	[illegible]	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
5	6	21	10	7	98.6	35.6	115333.	56.	493.	860.	24.	1.94	1.00	0.74	1.60
5	10	21	21	7	93.7	37.8	128322.	56.	56.	860.	80.	1.95	1.00	0.45	1.55
5	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46

SYSTEM 3 - 3 LIGHT= 7 MEDIUM=10 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)								
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	409.	0.	0.	76.	0.	0.	76.	17.	5.	15.	1.	4.4	1.3	37.	7.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	16.	1.	4.7	1.4	39.	8.
1	TOT	25292.	0.	2565.	4726.	0.	1869.	6595.	1517	437.	1345.	117.	349.3	105.2	3212.	660.
2	6	0.	414.	0.	0.	102.	0.	102.	33.	9.	51.	2.	1.4	0.4	86.	12.
2	10	616.	0.	248.	115.	0.	181.	296.	98.	28.	149.	6.	2.8	0.8	250.	35.
2	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	40.	1.	1.1	0.3	68.	9.
2	TOT	18147.	2485.	497.	3390.	613.	362.	4366.	1447.	418.	2197.	92.	60.9	18.3	3705.	529.
3	6	361.	0.	61.	67.	0.	44.	112.	37.	10.	80.	3.	1.2	0.3	119.	14.
3	10	621.	0.	256.	116.	0.	187.	303.	100.	29.	219.	8.	2.2	0.6	321.	38.
3	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	58.	2.	0.8	0.2	86.	10.
3	TOT	7342.	0.	440.	1372.	0.	320.	1692.	561.	162.	1222.	47.	17.4	5.2	1801.	214.
4	6	0.	505.	0.	0.	124.	0.	124.	28.	8.	40.	11.	1.3	0.4	70.	20.
4	10	667.	0.	333.	124.	0.	243.	368.	84.	24.	118.	34.	2.6	0.8	205.	59.
4	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	26.	7.	0.8	0.2	45.	13.
4	TOT	24954.	2020.	333.	4662.	498.	243.	5404.	1243.	358.	1736.	503.	57.9	17.4	3038.	879.
5	6	324.	236.	118.	60.	58.	86.	204.	11.	3.	63.	29.	2.2	0.6	78.	33.
5	10	765.	0.	496.	142.	0.	361.	504.	29.	7.	157.	73.	3.6	1.1	190.	82.
5	17	433.	0.	0.	81.	0.	0.	81.	4.	1.	25.	11.	0.8	0.2	30.	13.
5	TOT	7375.	708.	850.	1378.	174.	619.	2173.	127.	33.	676.	317.	21.9	6.6	826.	357.
TOTAL		83114.	5214.	4687.	15530.	1286.	3416.	20233.	4897.	1410.	7178.	1078.	507.7	152.9	12584.	2641.

SYSTEM 3 - 3   LIGHT= 7 MEDIUM=10 HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

				SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)															
		SORT-		ORIGIN-FIELD		EM-	RE-	FIELD-COMMZ		RECOVERED VALUE		FIXED			TOTAL		COST-EFF.	
T	A	IES	INITIAL	AIR	SURF.	PLACE	COVER	AIR	SURF.	AIR	SURF.	AIR	SURF.	MAINT.	AIR	SURF.	AIR	SURF.
1	6	98.	257.	37.	7.	4.	7.	4.9	1.2	260.	235.	51.	42.	0.330	51.	42.	41.	34.
1	10	420.	1854.	294.	59.	57.	40.	21.[illegible]	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	273.	39.	8.	4.	7.	4.2	1.2	261.	235.	68.	59.	11.591	79.	70.	54.	48.
1	TOT		21509.	3212.	660.	442.	566.	314.4	94.7	21153.	19076.	78.	67.	8.871	87.	76.	60.	52.
2	6	98.	331.	86.	12.	5.	8.	1.3	0.4	374.	308.	59.	50.	0.268	60.	50.	44.	37.
2	10	420.	928.	250.	35.	25.	25.	2.6	0.7	1058.	866.	174.	149.	0.439	175.	150.	109.	93.
2	17	5400.	273.	68.	9.	4.	7.	1.0	0.3	290.	238.	64.	57.	11.591	76.	68.	52.	47.
2	TOT		14509.	3705.	529.	264.	398.	54.8	16.5	15699.	12879.	68.	60.	9.671	73.	70.	53.	47.
3	6	98.	360.	119.	14.	8.	9.	1.1	0.3	430.	336.	67.	55.	0.146	68.	55.	44.	36.
3	10	420.	948.	321.	38.	26.	25.	1.9	0.6	1141.	887.	184.	152.	0.447	184.	153.	114.	95.
3	17	5400.	273.	86.	10.	4.	7.	0.8	0.2	306.	238.	65.	57.	11.591	77.	68.	53.	47.
3	TOT		5584.	1801.	214.	110.	152.	15.7	4.7	6418.	5001.	73.	62.	8.916	82.	71.	55.	48.
4	6	98.	404.	70.	20.	7.	11.	1.2	0.3	425.	381.	69.	62.	0.336	69.	62.	55.	50.
4	10	420.	1145.	205.	59.	33.	31.	2.4	0.7	1212.	1082.	205.	187.	0.532	205.	187.	129.	117.
4	17	5400.	273.	45.	13.	4.	7.	0.8	0.2	270.	241.	61.	57.	11.591	73.	69.	50.	47.
4	TOT		18073.	3038.	879.	318.	498.	52.1	15.7	18033.	16127.	64.	59.	10.672	75.	70.	51.	48.
5	6	98.	649.	78.	33.	16.	17.	2.0	0.6	652.	614.	110.	103.	0.132	110.	103.	69.	64.
5	10	420.	1558.	190.	82.	47.	43.	3.3	1.0	1570.	1475.	273.	257.	0.712	273.	258.	175.	165.
5	17	5400.	273.	30.	13.	4.	7.	0.8	0.2	256.	241.	60.	57.	11.591	72.	69.	49.	47.
5	TOT		7062.	826.	357.	155.	194.	19.7	5.9	6867.	6459.	81.	77.	8.929	90.	86.	60.	57.
TOTAL			66738.	12584.	2641.	1291.	1811.	456.9	137.6	68173.	59544.	72.	64.	9.602	81.	73.	55.	50.

SYSTEM 3 - 4   LIGHT= 8   MEDIUM=10   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	8	8	8	94.2	8.5	2658.	716.	716.	716.	4.	1.14	1.00	1.79	1.25
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
2	6	8	8	8	94.1	8.4	2703.	716.	716.	716.	4.	1.13	1.00	1.79	1.25
2	10	21	21	8	99.2	68.4	86388.	56.	56.	716.	43.	1.99	1.00	0.52	1.60
2	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
3	6	21	8	8	98.6	35.8	64378.	56.	716.	716.	13.	1.94	1.00	0.76	1.61
3	10	21	21	8	99.2	66.7	88241.	56.	56.	716.	45.	1.99	1.00	0.52	1.60
3	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
4	6	10	10	10	94.5	9.0	7676.	493.	493.	493.	8.	1.18	1.00	1.64	1.25
4	10	21	21	8	99.0	53.5	106356.	56.	56.	716.	56.	1.99	1.00	0.48	1.59
4	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
5	6	21	10	8	98.6	35.6	133100.	56.	493.	716.	25.	1.94	1.00	0.72	1.60
5	10	21	21	8	98.7	37.8	144547.	56.	56.	716.	82.	1.95	1.00	0.44	1.55
5	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58

SYSTEM 3 - 4 LIGHT= 8 MEDIUM=10 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)								
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	408.	0.	0.	83.	0.	0.	83.	19.	5.	17.	1.	4.8	1.4	41.	8.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	423.	0.	0.	86.	0.	0.	86.	19.	5.	17.	1.	5.0	1.5	42.	8.
1	TOT	24818.	0.	2565.	5081.	0.	1869.	6951.	1599.	460.	1418.	124.	370.1	111.5	3387.	696.
2	6	415.	0.	0.	84.	0.	0.	84.	28.	8.	42.	1.	1.2	0.3	72.	10.
2	10	616.	0.	248.	126.	0.	181.	307.	101.	29.	154.	6.	2.9	0.9	259.	36.
2	17	423.	0.	0.	86.	0.	0.	86.	28.	8.	43.	1.	1.2	0.3	73.	10.
2	TOT	20251.	0.	497.	4146.	0.	362.	4509.	1494.	432.	2268.	95.	62.9	18.9	3826.	546.
3	6	361.	0.	61.	73.	0.	44.	118.	39.	11.	85.	3.	1.2	0.3	126.	15.
3	10	621.	0.	256.	127.	0.	137.	314.	104.	30.	227.	8.	2.2	0.6	333.	39.
3	17	423.	0.	0.	86.	0.	0.	86.	28.	8.	62.	2.	0.9	0.2	92.	11.
3	TOT	721[illegible]	0.	440.	1476.	0.	320.	1797.	595.	172.	1298.	50.	18.5	5.5	1913.	228.
4	6	0.	505.	0.	0.	124.	0.	124.	28.	8.	40.	11.	1.3	0.4	70.	20.
4	10	667.	0.	333.	136.	0.	243.	379.	87.	25.	122.	35.	2.7	0.8	212.	61.
4	17	423.	0.	0.	86.	0.	0.	86.	19.	5.	27.	8.	0.9	0.2	48.	14.
4	TOT	24400.	2020.	333.	4995.	498.	243.	5737.	1320.	380.	1843.	535.	61.5	18.5	3225.	933.
5	6	324.	236.	118.	66.	58.	86.	210.	12.	3.	65.	30.	2.3	0.6	80.	34.
5	10	764.	0.	496.	156.	0.	361.	518.	30.	8.	161.	75.	3.7	1.1	195.	84.
5	17	423.	0.	0.	86.	0.	0.	86.	5.	1.	27.	12.	0.9	0.2	33.	14.
5	TOT	7246.	703.	850.	1483.	174.	619.	2278.	133.	35.	709.	332.	23.0	6.9	866.	375.
TOTAL		83932.	2729.	4687.	17184.	673.	3416.	21274.	5143.	1430.	7538.	1137.	536.3	161.5	13218.	2780.

SYSTEM 3 - 4   LIGHT= 8 MEDIUM=10 HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

				SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)														
		SORT-		ORIGIN-FIELD		EM-	RE-	FIELD-COMMZ		RECOVERED VALUE		FIXED			TOTAL		COST-EFF.	
T	A	IES	INITIAL	AIR	SURF.	PLACE	COVER	AIR	SURF.	AIR	SURF.	AIR	SURF.	MAINT.	AIR	SURF.	AIR	SURF.
1	6	98.	278.	41.	8.	4.	7.	4.4	1.3	282.	255.	54.	45.	0.300	54.	45.	43.	36.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	288.	42.	8.	4.	7.	4.5	1.3	282.	254.	66.	56.	7.769	74.	64.	46.	40.
1	TOT		22470.	3387.	696.	460.	588.	333.1	100.3	22385.	20196.	78.	66.	5.968	84.	72.	55.	47.
2	6	98.	282.	72.	10.	5.	8.	1.1	0.3	317.	262.	51.	44.	0.306	52.	44.	41.	35.
2	10	420.	959.	259.	36.	26.	25.	2.6	0.8	1094.	895.	180.	154.	0.434	180.	154.	112.	96.
2	17	5400.	288.	73.	10.	4.	7.	1.1	0.3	313.	257.	62.	54.	7.769	70.	62.	44.	39.
2	TOT		14875.	3826.	546.	272.	409.	56.6	17.0	16318.	13406.	66.	57.	6.504	72.	64.	47.	41.
3	6	98.	378.	126.	15.	8.	9.	1.1	0.3	452.	353.	71.	58.	0.109	71.	58.	44.	36.
3	10	420.	980.	333.	39.	27.	26.	2.0	0.6	1180.	916.	189.	157.	0.442	189.	157.	118.	98.
3	17	5400.	288.	92.	11.	4.	7.	0.8	0.2	330.	257.	64.	54.	7.769	71.	62.	45.	39.
3	TOT		5868.	1913.	228.	115.	158.	16.7	5.0	6836.	5331.	72.	61.	5.986	78.	67.	49.	42.
4	6	98.	404.	70.	20.	7.	11.	1.2	0.3	425.	381.	69.	62.	0.336	69.	62.	55.	50.
4	10	420.	1178.	212.	61.	33.	32.	2.5	0.7	1249.	1115.	210.	191.	0.528	210.	192.	132.	120.
4	17	5400.	288.	48.	14.	4.	7.	0.8	0.2	291.	260.	59.	55.	7.769	67.	62.	42.	39.
4	TOT		18962.	3225.	933.	336.	520.	55.3	16.6	19265.	17242.	62.	57.	7.163	70.	64.	44.	41.
5	6	98.	666.	80.	34.	16.	18.	2.0	0.6	669.	630.	113.	105.	0.132	113.	105.	70.	66.
5	10	420.	1597.	195.	84.	48.	43.	3.4	1.0	1609.	1512.	278.	262.	0.707	279.	263.	179.	169.
5	17	5400.	288.	33.	14.	4.	7.	0.8	0.2	277.	260.	58.	55.	7.769	65.	62.	41.	39.
5	TOT		7348.	866.	375.	160.	201.	20.7	6.2	7222.	6794.	80.	76.	6.006	86.	82.	54.	52.
TOTAL			69526.	13218.	2780.	1345.	1877.	482.7	145.4	72028.	62971.	70.	62.	6.453	77.	68.	49.	44.

SYSTEM 3 - 5 LIGHT= 7 MEDIUM=11 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	7	7	7	93.1	7.1	1742.	860.	860.	860.	3.	1.01	1.00	2.15	1.24
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
2	6	11	11	11	95.9	12.1	9598.	408.	408.	408.	8.	1.39	1.00	1.36	1.35
2	10	21	21	7	99.2	68.4	73715.	56.	56.	860.	42.	1.99	1.00	0.54	1.60
2	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
3	6	11	7	7	95.5	11.0	7077.	408.	860.	860.	4.	1.32	1.00	1.94	1.41
3	10	21	21	7	99.2	66.7	75470.	56.	56.	860.	43.	1.99	1.00	0.53	1.60
3	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
4	6	11	11	11	94.9	9.7	11710.	408.	408.	408.	10.	1.23	1.00	1.36	1.23
4	10	21	21	7	99.0	53.5	92635.	56.	56.	860.	55.	1.99	1.00	0.49	1.59
4	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
5	6	21	11	7	98.8	43.2	121078.	56.	408.	860.	25.	1.97	1.00	0.71	1.62
5	10	21	21	7	98.7	37.8	128822.	56.	56.	860.	80.	1.95	1.00	0.45	1.55
5	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46

SYSTEM 3 - 5 LIGHT= 7 MEDIUM=11 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES AREA (1000 SQ FT)			WEIGHT (TONS)				TRANSPORTATION COSTS ($1000) ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	409.	0.	0.	76.	0.	0.	76.	17.	5.	15.	1.	4.4	1.3	37.	7.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	16.	1.	4.7	1.4	39.	8.
1	TOT	25292.	0.	2565.	4726.	0.	1869.	6595.	1517.	437.	1345.	117.	349.3	105.2	3212.	660.
2	6	0.	413.	0.	0.	112.	0.	112.	37.	10.	56.	2.	1.6	0.4	95.	13.
2	10	616.	0.	248.	115.	0.	181.	296.	98.	28.	149.	6.	2.9	0.8	250.	35.
2	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	40.	1.	1.1	0.3	68.	9.
2	TOT	18147.	2483.	497.	3390.	673.	362.	4427.	1467.	424.	2227.	93.	61.8	18.6	3757.	536.
3	6	361.	61.	0.	67.	16.	0.	84.	27.	8.	60.	2.	0.9	0.2	89.	10.
3	10	621.	0.	256.	116.	0.	187.	303.	100.	29.	219.	8.	2.2	0.6	321.	38.
3	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	58.	2.	0.8	0.2	86.	10.
3	TOT	7342.	184.	256.	1372.	50.	187.	1609.	533.	154.	1162.	44.	16.5	4.9	1712.	204.
4	6	0.	504.	0.	0.	136.	0.	136.	31.	9.	44.	12.	1.5	0.4	77.	22.
4	10	667.	0.	333.	124.	0.	243.	368.	84.	24.	118.	34.	2.6	0.8	205.	59.
4	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	26.	7.	0.8	0.2	45.	13.
4	TOT	24954.	2019.	333.	4662.	547.	243.	5454.	1254.	361.	1752.	508.	58.4	17.6	3065.	887.
5	6	324.	236.	118.	60.	64.	86.	210.	12.	3.	65.	36.	2.3	0.6	80.	34.
5	10	765.	0.	496.	142.	0.	361.	504.	29.	7.	157.	73.	3.6	1.1	190.	82.
5	17	433.	0.	0.	81.	0.	0.	81.	4.	1.	25.	11.	0.8	0.2	30.	13.
5	TOT	7375.	708.	850.	1378.	192.	619.	2190.	128.	33.	682.	319.	22.1	6.6	832.	360.
TOTAL		83114.	5396.	4504.	15530.	1463.	3283.	20277.	4902.	1411.	7170.	1084.	508.4	153.1	12580.	2649.

SYSTEM 3 - 5 LIGHT= 7 MEDIUM=11 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

			SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)															
		SORT-		ORIGIN-FIELD		EM-	RE-	FIELD-COMMZ		RECOVERED VALUE		FIXED			TOTAL		COST-EFF.	
T	A	IES	INITIAL	AIR	SURF.	PLACE	COVER	AIR	SURF.	AIR	SURF.	AIR	SURF.	MAINT.	AIR	SURF.	AIR	SURF.
1	6	98.	257.	37.	7.	4.	7.	4.0	1.2	260.	236.	51.	42.	0.330	51.	42.	41.	34.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	273.	39.	8.	4.	7.	4.2	1.2	261.	235.	68.	59.	11.591	79.	70.	54.	48.
1	TOT		21509.	3212.	660.	442.	566.	314.4	94.7	21153.	19076.	78.	67.	8.871	87.	76.	60.	52.
2	6	98.	360.	95.	13.	6.	9.	1.4	0.4	408.	335.	64.	54.	0.257	64.	54.	48.	40.
2	10	420.	928.	250.	35.	25.	25.	2.6	0.7	1058.	866.	174.	149.	0.439	175.	150.	109.	93.
2	17	5400.	273.	68.	9.	4.	7.	1.0	0.3	290.	238.	64.	57.	11.591	76.	68.	52.	47.
2	TOT		14681.	3757.	536.	238.	401.	55.6	16.7	15900.	13041.	69.	60.	9.670	79.	70.	54.	48.
3	6	98.	281.	89.	10.	5.	8.	0.8	0.2	332.	261.	52.	43.	0.273	52.	43.	37.	30.
3	10	420.	948.	321.	38.	26.	25.	1.9	0.6	1141.	887.	184.	152.	0.447	184.	153.	114.	95.
3	17	5400.	273.	86.	10.	4.	7.	0.8	0.2	306.	238.	65.	57.	11.591	77.	68.	53.	47.
3	TOT		5346.	1712.	204.	101.	148.	14.8	4.4	6124.	4777.	70.	60.	8.938	79.	69.	53.	47.
4	6	98.	439.	77.	22.	8.	11.	1.3	0.4	462.	414.	74.	67.	0.325	75.	67.	60.	54.
4	10	420.	1145.	205.	59.	33.	31.	2.4	0.7	1212.	1082.	205.	187.	0.532	205.	187.	129.	117.
4	17	5400.	273.	45.	13.	4.	7.	0.8	0.2	270.	241.	61.	57.	11.591	73.	69.	50.	47.
4	TOT		18213.	3065.	887.	321.	501.	52.6	15.8	18184.	16261.	65.	60.	10.671	75.	70.	52.	48.
5	6	98.	666.	80.	34.	16.	18.	2.0	0.6	669.	630.	113.	105.	0.119	113.	106.	69.	65.
5	10	420.	1558.	190.	82.	47.	43.	3.3	1.0	1570.	1475.	273.	257.	0.712	273.	258.	175.	165.
5	17	5400.	273.	30.	13.	4.	7.	0.8	0.2	256.	241.	60.	57.	11.591	72.	69.	49.	47.
5	TOT		7111.	832.	360.	156.	195.	19.9	6.0	6917.	6506.	82.	77.	8.927	91.	86.	60.	57.
TOTAL			66862.	12580.	2649.	1289.	1813.	457.6	137.8	68281.	59663.	72.	64.	9.604	81.	73.	56.	50.

SYSTEM 3 - 6 LIGHT= 6 MEDIUM= 9 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	9	9	9	95.0	9.9	4063.	594.	594.	594.	5.	1.24	1.00	1.98	1.37
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.98	1.73
2	6	9	9	9	94.9	9.7	4130.	594.	594.	594.	5.	1.23	1.00	1.98	1.36
2	10	21	21	6	99.2	68.4	65427.	56.	56.	1029.	41.	1.99	1.00	0.55	1.60
2	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.98	1.73
3	6	21	6	6	96.3	13.4	58926.	56.	1029.	1029.	11.	1.47	1.00	0.84	1.29
3	10	21	21	6	99.2	66.7	67119.	56.	56.	1029.	42.	1.99	1.00	0.55	1.60
3	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.98	1.73
4	6	9	9	9	93.9	8.1	5038.	594.	594.	594.	7.	1.10	1.00	1.98	1.27
4	10	21	21	6	99.0	53.5	83662.	56.	56.	1029.	54.	1.99	1.00	0.50	1.59
4	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.98	1.73
5	6	21	9	6	98.2	23.3	99958.	56.	594.	1029.	23.	1.87	1.00	0.78	1.57
5	10	21	21	6	98.7	37.8	118540.	56.	56.	1029.	79.	1.95	1.00	0.46	1.55
5	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.98	1.73

SYSTEM 3 - 6   LIGHT= 6   MEDIUM= 9   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($ 1000)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	0.	407.	0.	0.	91.	0.	91.	21.	6.	18.	1.	5.3	1.6	45.	9.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	0.	417.	0.	0.	93.	0.	93.	21.	6.	19.	1.	5.4	1.6	46.	9.
1	TOT	0.	24506.	2565.	0.	5506.	1869.	7376.	1697.	488.	1504.	131.	395.0	119.0	3596.	739.
2	6	0.	414.	0.	0.	93.	0.	93.	30.	8.	46.	1.	1.3	0.4	79.	11.
2	10	617.	0.	248.	105.	0.	181.	286.	95.	27.	144.	6.	2.7	0.8	242.	34.
2	17	0.	417.	0.	0.	93.	0.	93.	31.	8.	47.	1.	1.3	0.4	79.	11.
2	TOT	1234.	18762.	497.	210.	4215.	362.	4789.	1587.	459.	2409.	101.	67.2	20.2	4064.	580.
3	6	361.	0.	61.	61.	0.	44.	106.	35.	10.	76.	2.	1.1	0.3	113.	13.
3	10	621.	0.	256.	106.	0.	187.	293.	97.	28.	211.	8.	2.1	0.6	311.	36.
3	17	0.	417.	0.	0.	93.	0.	93.	31.	8.	67.	2.	1.0	0.3	99.	11.
3	TOT	1705.	5425.	440.	291.	1218.	320.	1831.	607.	175.	1322.	51.	19.0	5.7	1948.	232.
4	6	0.	505.	0.	0.	113.	0.	113.	26.	7.	36.	10.	1.2	0.3	63.	18.
4	10	667.	0.	333.	114.	0.	243.	357.	82.	23.	114.	33.	2.6	0.7	199.	57.
4	17	0.	417.	0.	0.	93.	0.	93.	21.	6.	30.	8.	1.0	0.3	52.	15.
4	TOT	667.	25391.	333.	114.	5705.	243.	6062.	1394.	401.	1947.	565.	65.1	19.6	3408.	986.
5	6	324.	236.	118.	55.	53.	86.	194.	11.	3.	60.	28.	2.1	0.6	74.	32.
5	10	765.	0.	496.	130.	0.	361.	492.	28.	7.	153.	71.	3.6	1.0	185.	80.
5	17	0.	417.	0.	0.	93.	0.	93.	5.	1.	29.	13.	1.0	0.3	35.	15.
5	TOT	1737.	6134.	850.	296.	1378.	619.	2295.	134.	35.	714.	335.	23.3	7.0	872.	377.
TOTAL		5345.	80219.	4687.	913.	18024.	3416.	22354.	5421.	1560.	7899.	1184.	569.8	171.6	13890.	2917.

SYSTEM 3 - 6   LIGHT= 6   MEDIUM= 9   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

- - - - - - - - - - - - - - - - SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000) - - - - - - - - - - - - - - - -

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	300.	45.	9.	5.	8.	4.8	1.4	305.	277.	58.	48.	0.279	58.	48.	42.	35.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	307.	46.	9.	5.	8.	4.9	1.4	305.	276.	67.	56.	5.816	72.	62.	41.	35.
1	TOT		23645.	3596.	739.	482.	612.	355.5	107.1	23770.	21447.	79.	66.	4.483	83.	71.	51.	43.
2	6	98.	305.	79.	11.	5.	8.	1.2	0.3	344.	284.	55.	47.	0.284	55.	47.	40.	34.
2	10	420.	900.	242.	34.	25.	24.	2.5	0.7	1025.	840.	170.	146.	0.536	170.	146.	106.	91.
2	17	5400.	307.	79.	11.	5.	8.	1.2	0.3	339.	278.	62.	54.	5.816	68.	60.	39.	34.
2	TOT		15644.	4064.	580.	287.	425.	60.5	18.2	17353.	14260.	66.	57.	4.885	71.	62.	42.	37.
3	6	98.	343.	113.	13.	7.	9.	1.0	0.3	410.	321.	65.	53.	0.252	65.	53.	50.	41.
3	10	420.	920.	311.	36.	26.	25.	1.9	0.5	1106.	860.	179.	149.	0.546	179.	149.	111.	93.
3	17	5400.	307.	99.	11.	5.	8.	0.9	0.2	357.	279.	64.	54.	5.816	70.	60.	40.	34.
3	TOT		5955.	1948.	232.	117.	161.	17.1	5.1	6988.	5456.	71.	59.	4.524	75.	64.	46.	39.
4	6	98.	372.	63.	18.	6.	10.	1.1	0.3	391.	351.	64.	58.	0.352	64.	58.	50.	46.
4	10	420.	1114.	199.	57.	32.	30.	2.3	0.7	1180.	1053.	200.	182.	0.646	201.	183.	126.	115.
4	17	5400.	307.	52.	15.	5.	8.	0.9	0.2	315.	282.	59.	54.	5.816	65.	60.	37.	34.
4	TOT		19848.	3408.	986.	353.	539.	58.6	17.6	20411.	18273.	62.	56.	5.373	67.	62.	39.	36.
5	6	98.	620.	74.	32.	15.	17.	1.9	0.5	622.	586.	106.	99.	0.153	106.	99.	67.	63.
5	10	420.	1523.	185.	80.	47.	42.	3.2	0.9	1534.	1442.	267.	252.	0.858	268.	253.	172.	162.
5	17	5400.	307.	35.	15.	5.	8.	0.9	0.2	300.	282.	57.	54.	5.816	63.	60.	36.	34.
5	TOT		7387.	872.	377.	162.	202.	21.0	6.3	7305.	6875.	78.	74.	4.525	83.	78.	50.	47.
TOTAL			72481.	13890.	2917.	1403.	1942.	512.8	154.5	75830.	66312.	70.	61.	4.848	75.	66.	45.	39.

SYSTEM 3 - 7   LIGHT= 7   MEDIUM=10   HEAVY=17   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

T	A	CLASS E	CLASS C	CLASS T	AVAILABILITY 0/0	AVAILABILITY SORTIES	S.L. SORTIES	PLACEMENT RATE E	PLACEMENT RATE C	PLACEMENT RATE T	PLACEMENT RATE SORTIES	NORMALIZED AVAIL	NORMALIZED S.L.	NORMALIZED P.R.	NORMALIZED EFFECT.
1	6	7	7	7	93.1	7.1	1742.	860.	860.	860.	3.	1.01	1.00	2.15	1.24
1	10	17	17	17	97.5	19.9	62276.	126.	126.	126.	56.	1.72	1.00	0.63	1.43
1	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
2	6	10	10	10	95.5	11.0	6292.	493.	493.	493.	6.	1.32	1.00	1.64	1.35
2	10	17	17	7	97.4	19.5	33287.	126.	126.	860.	22.	1.71	1.00	1.03	1.50
2	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
3	6	17	7	7	96.4	13.6	16419.	126.	860.	860.	7.	1.48	1.00	1.33	1.40
3	10	17	17	7	97.4	19.0	33762.	126.	126.	860.	22.	1.69	1.00	1.03	1.49
3	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
4	6	10	10	10	94.5	9.0	7676.	493.	493.	493.	8.	1.18	1.00	1.64	1.25
4	10	17	17	7	96.7	15.2	38414.	126.	126.	860.	28.	1.55	1.00	0.97	1.38
4	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46
5	6	17	10	7	97.7	21.7	57794.	126.	493.	860.	14.	1.76	1.00	1.22	1.58
5	10	17	17	7	95.4	10.8	48220.	126.	126.	860.	40.	1.31	1.00	0.91	1.20
5	17	0	0	7	95.5	11.0	7619.	0.	0.	860.	3.	1.33	1.00	2.15	1.46

SYSTEM 3 - 7   LIGHT= 7 MEDIUM=10 HEAVY=17   ORIGIN= 1   CASE= 2   PARAMETEP, - 1 PASS

T	A	AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES AREA (1000 SQ FT) LIGHT	MEDIUM	HEAVY	WEIGHT (TONS) LIGHT	MEDIUM	HEAVY	TOTAL	TRANSPORTATION COSTS ($1000) ORIGIN-PORT AIR	TRUCK	CONUS-COMMZ AIR	SHIP	COMMZ-FIELD AIR	TRUCK	TOTAL AIR	SURFACE
1	6	409.	0.	0.	76.	0.	0.	76.	17.	5.	15.	1.	4.4	1.3	37.	7.
1	10	0.	0.	855.	0.	0.	416.	416.	95.	27.	85.	7.	16.2	4.8	197.	39.
1	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	16.	1.	4.7	1.4	39.	8.
1	TOT	25292.	0.	2566.	4726.	0.	1250.	5976.	1375.	396.	1219.	106.	325.2	97.9	2919.	600.
2	6	0.	414.	0.	0.	102.	0.	102.	33.	9.	51.	2.	1.4	0.4	86.	12.
2	10	616.	0.	249.	115.	0.	121.	236.	78.	22.	119.	4.	2.3	0.6	199.	28.
2	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	40.	1.	1.1	0.3	68.	9.
2	TOT	18147.	2485.	498.	3390.	613.	243.	4247.	1407.	407.	2136.	89.	59.8	18.0	3604.	514.
3	6	361.	0.	51.	67.	0.	29.	97.	32.	9.	70.	2.	1.0	0.3	103.	12.
3	10	621.	0.	257.	116.	0.	125.	241.	80.	23.	174.	6.	1.7	0.5	256.	30.
3	17	433.	0.	0.	81.	0.	0.	81.	26.	7.	58.	2.	0.8	0.2	86.	10.
3	TOT	7342.	0.	440.	1372.	0.	214.	1586.	526.	152.	1146.	44.	16.5	4.9	1688.	201.
4	6	0.	505.	0.	0.	124.	0.	124.	28.	8.	40.	11.	1.3	0.4	70.	20.
4	10	667.	0.	334.	124.	0.	162.	287.	66.	19.	92.	26.	2.1	0.6	160.	46.
4	17	433.	0.	0.	81.	0.	0.	81.	18.	5.	26.	7.	0.8	0.2	45.	13.
4	TOT	24954.	2020.	334.	4662.	498.	162.	5324.	1225.	352.	1710.	496.	57.3	17.2	2993.	866.
5	6	324.	236.	118.	60.	58.	57.	176.	10.	2.	54.	25.	1.9	0.5	67.	29.
5	10	765.	0.	496.	142.	0.	241.	384.	22.	5.	119.	56.	2.8	0.8	145.	63.
5	17	433.	0.	0.	81.	0.	0.	81.	4.	1.	25.	11.	0.8	0.2	30.	13.
5	TOT	7375.	708.	851.	1378.	174.	414.	1967.	115.	30.	612.	287.	20.1	6.0	748.	324.
TOTAL		83114.	5214.	4691.	15530.	1286.	2285.	19102.	4649.	1338.	6825.	1024.	479.0	144.3	11954.	2507.

SYSTEM 3 - 7 LIGHT= 7 MEDIUM=10 HEAVY=17 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

				SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)															
		SORT-		ORIGIN-FIELD		EM-	RE-	FIELD-COMMZ		RECOVERED VALUE		FIXED			TOTAL		COST-EFF.	
T	A	IES	INITIAL	AIR	SURF.	PLACE	COVER	AIR	SURF.	AIR	SURF.	AIR	SURF.	MAINT.	AIR	SURF.	AIR	SURF.
1	6	98.	257.	37.	7.	4.	7.	4.0	1.2	260.	236.	51.	42.	0.330	51.	42.	41.	34.
1	10	420.	1268.	197.	39.	31.	31.	14.6	4.4	1304.	1172.	238.	202.	0.891	239.	203.	167.	142.
1	17	5400.	273.	39.	8.	4.	7.	4.2	1.2	261.	235.	68.	59.	11.591	79.	70.	54.	48.
1	TOT		19751.	2919.	600.	362.	538.	292.7	88.1	19328.	17445.	73.	62.	8.894	82.	71.	57.	50.
2	6	98.	331.	86.	12.	5.	8.	1.3	0.4	374.	308.	59.	50.	0.268	60.	50.	44.	37.
2	10	420.	758.	199.	28.	18.	22.	2.0	0.6	859.	706.	141.	121.	0.925	142.	122.	94.	81.
2	17	5400.	273.	68.	9.	4.	7.	1.0	0.3	290.	238.	64.	57.	11.591	76.	68.	52.	47.
2	TOT		14169.	3604.	514.	249.	393.	53.8	16.2	15302.	12559.	67.	59.	9.692	77.	68.	53.	47.
3	6	98.	318.	103.	12.	6.	8.	0.9	0.2	378.	297.	59.	48.	0.250	59.	49.	42.	34.
3	10	420.	773.	256.	30.	18.	23.	1.5	0.4	924.	721.	148.	124.	0.946	149.	125.	100.	83.
3	17	5400.	273.	86.	10.	4.	7.	0.8	0.2	306.	238.	65.	57.	11.591	77.	68.	53.	47.
3	TOT		5282.	1688.	201.	96.	147.	14.8	4.4	6046.	4718.	69.	59.	8.964	78.	68.	53.	47.
4	6	98.	404.	70.	20.	7.	11.	1.2	0.3	425.	381.	69.	62.	0.336	69.	62.	55.	50.
4	10	420.	916.	160.	46.	22.	27.	1.8	0.5	966.	865.	163.	149.	1.150	164.	150.	118.	108.
4	17	5400.	273.	45.	13.	4.	7.	0.8	0.2	270.	241.	61.	57.	11.591	73.	69.	50.	47.
4	TOT		17845.	2993.	866.	308.	495.	51.6	15.5	17787.	15910.	64.	59.	10.682	74.	70.	51.	48.
5	6	98.	568.	67.	29.	12.	16.	1.7	0.5	570.	537.	96.	89.	0.185	96.	90.	60.	56.
5	10	420.	1218.	145.	63.	32.	37.	2.5	0.7	1224.	1151.	212.	200.	1.579	214.	202.	178.	168.
5	17	5400.	273.	30.	13.	4.	7.	0.8	0.2	256.	241.	60.	57.	11.591	72.	69.	49.	47.
5	TOT		6479.	748.	324.	128.	185.	18.1	5.4	6273.	5904.	75.	71.	8.990	84.	80.	58.	56.
TOTAL			63528.	11954.	2507.	1145.	1760.	431.1	129.9	64738.	56538.	69.	61.	9.626	78.	71.	54.	49.

SYSTEM 3 - 8   LIGHT= 5   MEDIUM= 9   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	9	9	9	95.0	9.9	4063.	594.	594.	594.	5.	1.24	1.00	1.98	1.37
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.98	1.73
2	6	9	9	9	94.9	9.7	4130.	594.	594.	594.	5.	1.23	1.00	1.98	1.36
2	10	21	21	5	99.2	68.4	59990.	56.	56.	1228.	40.	1.99	1.00	0.56	1.61
2	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.98	1.73
3	6	21	5	5	96.1	12.6	57511.	56.	1228.	1228.	11.	1.42	1.00	0.87	1.27
3	10	21	21	5	99.2	66.7	61640.	56.	56.	1228.	42.	1.99	1.00	0.56	1.61
3	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.98	1.73
4	6	9	9	9	93.9	8.1	5038.	594.	594.	594.	7.	1.10	1.00	1.98	1.27
4	10	21	21	9	99.0	53.5	127379.	56.	56.	594.	58.	1.99	1.00	0.55	1.60
4	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.98	1.73
5	6	21	9	5	98.2	28.3	92335.	56.	594.	1228.	22.	1.87	1.00	0.79	1.57
5	10	21	21	5	98.7	37.8	111793.	56.	56.	1228.	78.	1.95	1.00	0.46	1.56
5	17	0	0	9	97.7	21.9	17766.	0.	0.	594.	5.	1.77	1.00	1.98	1.73

SYSTEM 3 - 8   LIGHT= 5   MEDIUM= 9   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	0.	407.	0.	0.	91.	0.	91.	21.	6.	18.	1.	5.3	1.6	45.	9.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	0.	417.	0.	0.	93.	0.	93.	21.	6.	19.	1.	5.4	1.6	46.	9.
1	TOT	0.	24506.	2565.	0.	5506.	1869.	7376.	1697.	488.	1504.	131.	395.0	119.0	3596.	739.
2	5	0.	414.	0.	0.	93.	0.	93.	30.	8.	46.	1.	1.3	0.4	79.	11.
2	10	617.	0.	248.	96.	0.	181.	277.	92.	26.	139.	5.	2.7	0.8	234.	33.
2	17	0.	417.	0.	0.	93.	0.	93.	31.	8.	47.	1.	1.3	0.4	79.	11.
2	TOT	1234.	18762.	497.	193.	4215.	362.	4771.	1581.	457.	2400.	100.	67.0	20.2	4049.	578.
3	6	361.	0.	61.	56.	0.	44.	101.	33.	9.	73.	2.	1.1	0.3	107.	12.
3	10	622.	0.	256.	97.	0.	187.	284.	94.	27.	205.	7.	2.0	0.6	301.	35.
3	17	0.	417.	0.	0.	93.	0.	93.	31.	8.	67.	2.	1.0	0.3	99.	11.
3	TOT	1706.	5425.	440.	266.	1218.	320.	1806.	598.	173.	1305.	50.	18.7	5.6	1922.	229.
4	6	0.	505.	0.	0.	113.	0.	113.	26.	7.	36.	10.	1.2	0.3	63.	18.
4	10	0.	667.	333.	0.	149.	243.	3[illegible]3.	90.	26.	126.	36.	2.8	0.8	219.	53.
4	17	0.	417.	0.	0.	93.	0.	93.	21.	6.	30.	8.	1.0	0.3	52.	15.
4	TOT	0.	26053.	333.	0.	5854.	243.	6098.	1403.	404.	1959.	568.	65.4	19.7	3428.	992.
5	6	324.	236.	118.	50.	53.	86.	189.	11.	2.	59.	27.	2.0	0.6	72.	31.
5	10	765.	0.	496.	119.	0.	361.	481.	28.	7.	149.	70.	3.5	1.0	181.	78.
5	17	0.	417.	0.	0.	93.	0.	93.	5.	1.	29.	13.	1.0	0.3	35.	15.
5	TOT	1738.	6134.	850.	271.	1378.	619.	2270.	132.	35.	707.	331.	23.1	6.9	863.	373.
TOTAL		4679.	80886.	4687.	731.	18174.	3416.	22322.	5413.	1558.	7876.	1183.	569.4	171.5	13860.	2913.

SYSTEM 3 - 8 LIGHT= 5 MEDIUM= 9 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	300.	45.	9.	5.	3.	4.8	1.4	305.	277.	58.	48.	0.279	58.	48.	42.	35.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	307.	46.	9.	5.	3.	4.9	1.4	305.	276.	67.	56.	5.816	72.	62.	41.	35.
1	TOT		23645.	3596.	739.	482.	612.	355.5	107.1	23770.	21447.	79.	66.	4.483	83.	71.	51.	43.
2	6	98.	305.	79.	11.	5.	8.	1.2	0.3	344.	284.	55.	47.	0.284	55.	47.	40.	34.
2	10	420.	875.	234.	33.	25.	24.	2.4	0.7	996.	816.	166.	142.	0.757	167.	143.	103.	89.
2	17	5400.	307.	79.	11.	5.	8.	1.2	0.3	339.	278.	62.	54.	5.816	68.	60.	39.	34.
2	TOT		15594.	4049.	578.	286.	424.	60.3	18.1	17294.	14213.	66.	57.	4.894	71.	62.	42.	36.
3	6	98.	329.	107.	12.	7.	8.	0.9	0.3	391.	307.	62.	51.	0.259	62.	51.	49.	40.
3	10	420.	895.	301.	35.	25.	24.	1.8	0.5	1074.	836.	175.	145.	0.770	175.	146.	109.	91.
3	17	5400.	307.	99.	11.	5.	8.	0.9	0.2	357.	279.	64.	54.	5.816	70.	60.	40.	34.
3	TOT		5835.	1922.	229.	116.	159.	16.8	5.0	6902.	5390.	70.	59.	4.538	75.	63.	45.	38.
4	6	98.	372.	63.	18.	6.	10.	1.1	0.3	391.	351.	64.	58.	0.352	64.	58.	50.	46.
4	10	420.	1216.	219.	63.	34.	32.	2.5	0.7	1289.	1150.	216.	196.	0.524	216.	197.	135.	123.
4	17	5400.	307.	52.	15.	5.	8.	0.9	0.2	315.	282.	59.	54.	5.816	65.	60.	37.	34.
4	TOT		13950.	3428.	992.	355.	541.	58.9	17.7	20521.	18370.	62.	57.	5.371	67.	62.	40.	36.
5	6	98.	606.	72.	31.	15.	17.	1.8	0.5	609.	573.	104.	97.	0.154	104.	97.	66.	62.
5	10	420.	1492.	181.	78.	46.	42.	3.1	0.9	1503.	1412.	263.	248.	1.192	264.	250.	169.	160.
5	17	5400.	307.	35.	15.	5.	8.	0.9	0.2	300.	282.	57.	54.	5.816	63.	60.	36.	34.
5	TOT		7316.	863.	373.	161.	201.	20.8	6.2	7233.	6807.	78.	73.	4.545	82.	73.	49.	46.
TOTAL			72393.	13860.	2913.	1402.	1940.	512.5	154.4	75722.	66228.	70.	61.	4.853	75.	66.	45.	39.

SYSTEM 3 - 9 LIGHT= 6 MEDIUM=10 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	10	10	10	95.6	11.1	6189.	493.	493.	493.	6.	1.34	1.00	1.64	1.36
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.64	1.77
2	6	10	10	10	95.5	11.0	6292.	493.	493.	493.	6.	1.32	1.00	1.64	1.35
2	10	21	21	6	99.2	68.4	65427.	56.	56.	1029.	41.	1.99	1.00	0.55	1.60
2	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.64	1.77
3	6	21	6	6	96.3	13.4	58926.	56.	1029.	1029.	11.	1.47	1.00	0.84	1.29
3	10	21	21	6	99.2	66.7	67119.	56.	56.	1029.	42.	1.99	1.00	0.55	1.60
3	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.64	1.77
4	6	10	10	10	94.5	9.0	7676.	493.	493.	493.	8.	1.18	1.00	1.64	1.25
4	10	21	21	6	99.0	53.5	83662.	56.	56.	1029.	54.	1.99	1.00	0.50	1.59
4	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.64	1.77
5	6	21	10	6	98.6	35.6	103715.	56.	493.	1029.	24.	1.94	1.00	0.75	1.61
5	10	21	21	6	93.7	37.8	118540.	56.	56.	1029.	79.	1.95	1.00	0.46	1.55
5	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.64	1.77

SYSTEM 3 - 9   LIGHT= 6   MEDIUM=10   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)								
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL		
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	0.	407.	0.	0.	100.	0.	100.	23.	6.	20.	1.	5.8	1.7	49.	10.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	0.	413.	0.	0.	101.	0.	101.	23.	6.	20.	1.	5.9	1.7	50.	10.
1	TOT	0.	24303.	2565.	0.	5995.	1869.	7865.	1809.	521.	1604.	140.	423.6	127.6	3838.	789.
2	6	0.	414.	0.	0.	102.	0.	102.	33.	9.	51.	2.	1.4	0.4	86.	12.
2	10	617.	0.	248.	105.	0.	181.	286.	95.	27.	144.	6.	2.7	0.8	242.	34.
2	17	0.	413.	0.	0.	101.	0.	101.	33.	9.	51.	2.	1.4	0.4	86.	12.
2	TOT	1234.	18595.	497.	210.	4587.	362.	5161.	1710.	494.	2596.	108.	72.6	21.8	4380.	625.
3	6	361.	0.	61.	61.	0.	44.	106.	35.	10.	76.	2.	1.1	0.3	113.	13.
3	10	621.	0.	256.	106.	0.	187.	293.	97.	28.	211.	8.	2.1	0.6	311.	36.
3	17	0.	413.	0.	0.	101.	0.	101.	33.	9.	73.	2.	1.1	0.3	108.	12.
3	TOT	1705.	5370.	440.	291.	1324.	320.	1936.	642.	185.	1399.	54.	20.1	6.0	2061.	245.
4	6	0.	505.	0.	0.	124.	0.	124.	28.	8.	40.	11.	1.3	0.4	70.	20.
4	10	667.	0.	333.	114.	0.	243.	357.	82.	23.	114.	33.	2.6	0.7	199.	57.
4	17	0.	413.	0.	0.	101.	0.	101.	23.	6.	32.	9.	1.1	0.3	57.	16.
4	TOT	667.	25153.	333.	114.	6205.	243.	6562.	1510.	434.	2108.	611.	70.6	21.2	3689.	1068.
5	6	324.	236.	118.	55.	58.	86.	199.	11.	3.	62.	29.	2.1	0.6	76.	32.
5	10	765.	0.	496.	130.	0.	361.	492.	28.	7.	153.	71.	3.6	1.0	185.	80.
5	17	0.	413.	0.	0.	101.	0.	101.	5.	1.	31.	14.	1.1	0.3	38.	16.
5	TOT	1737.	6078.	850.	296.	1499.	619.	2416.	141.	37.	752.	353.	24.7	7.4	918.	397.
TOTAL		5345.	79501.	4687.	913.	19612.	3416.	23942.	5814.	1674.	8461.	1268.	611.9	184.3	14887.	3127.

SYSTEM 3 - 9   LIGHT= 6   MEDIUM=10   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	326.	49.	10.	5.	8.	5.2	1.5	332.	300.	63.	51.	0.263	63.	52.	46.	38.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	330.	50.	10.	5.	8.	5.3	1.6	331.	299.	69.	57.	3.899	72.	61.	41.	34.
1	TOT		25014.	3838.	789.	508.	639.	331.3	114.8	25306.	22829.	81.	68.	3.027	84.	71.	51.	43.
2	6	98.	331.	86.	12.	5.	8.	1.3	0.4	374.	308.	59.	50.	0.268	60.	50.	44.	37.
2	10	420.	900.	242.	34.	25.	24.	2.5	0.7	1025.	840.	170.	146.	0.536	170.	146.	106.	91.
2	17	5400.	330.	86.	12.	5.	8.	1.3	0.4	368.	302.	64.	55.	3.899	68.	59.	38.	33.
2	TOT		16683.	4380.	625.	307.	445.	65.4	19.7	18660.	15327.	68.	58.	3.293	71.	61.	42.	36.
3	6	98.	343.	113.	13.	7.	9.	1.0	0.3	410.	321.	65.	53.	0.252	65.	53.	50.	41
3	10	420.	920.	311.	36.	26.	25.	1.9	0.5	1106.	860.	179.	149.	0.546	179.	149.	111.	93.
3	17	5400.	330.	108.	12.	5.	8.	1.0	0.3	388.	303.	66.	55.	3.899	70.	59.	39.	33.
3	TOT		6250.	2061.	245.	123.	166.	18.1	5.4	7385.	5763.	72.	60.	3.058	75.	63.	45.	38.
4	6	98.	404.	70.	20.	7.	11.	1.2	0.3	425.	381.	69.	62.	0.336	69.	62.	55.	50.
4	10	420.	1114.	199.	57.	32.	30.	2.3	0.7	1180.	1053.	200.	182.	0.646	201.	183.	126.	115.
4	17	5400.	330.	57.	16.	5.	8.	1.0	0.3	342.	306.	61.	55.	3.899	64.	59.	36.	33.
4	TOT		21244.	3689.	1068.	381.	567.	63.6	19.1	22048.	19734.	63.	58.	3.612	67.	61.	39.	35.
5	6	98.	634.	76.	32.	15.	17.	1.9	0.5	637.	600.	108.	101.	0.133	108.	101.	67.	63.
5	10	420.	1523.	185.	80.	47.	42.	3.2	0.9	1534.	1442.	267.	252.	0.858	268.	253.	172.	162.
5	17	5400.	330.	38.	16.	5.	8.	1.0	0.3	325.	306.	59.	55.	3.899	63.	59.	35.	33.
5	TOT		7726.	918.	397.	168.	209.	22.2	6.6	7681.	7228.	80.	75.	3.056	83.	78.	49.	46.
TOTAL			76919.	14887.	3127.	1490.	2028.	550.7	165.9	81083.	70883.	72.	62.	3.268	75.	66.	44.	39.

SYSTEM 3 -10   LIGHT= 6   MEDIUM=11   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	11	11	11	96.0	12.7	9442.	408.	408.	408.	8.	1.41	1.00	1.36	1.36
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.36	1.74
2	6	11	11	11	95.9	12.1	9598.	408.	408.	408.	8.	1.33	1.00	1.36	1.35
2	10	21	21	6	99.2	68.4	65427.	56.	56.	1029.	41.	1.99	1.00	0.55	1.60
2	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.36	1.74
3	6	11	6	6	95.3	10.6	4922.	408.	1029.	1029.	4.	1.30	1.00	2.21	1.45
3	10	21	21	6	99.2	66.7	67119.	56.	56.	1029.	42.	1.99	1.00	0.55	1.60
3	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.36	1.74
4	6	11	11	11	94.9	9.7	11710.	408.	408.	408.	10.	1.23	1.00	1.36	1.23
4	10	21	21	6	99.0	53.5	83662.	56.	56.	1029.	54.	1.99	1.00	0.50	1.59
4	17	0	0	11	93.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.36	1.74
5	6	21	11	6	98.8	43.2	109459.	56.	408.	1029.	24.	1.97	1.00	0.73	1.62
5	10	21	21	6	98.7	37.8	118540.	56.	56.	1029.	79.	1.95	1.00	0.46	1.55
5	17	0	0	11	93.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	2.36	1.74

SYSTEM 3 -10 LIGHT= 6 MEDIUM=11 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	0.	407.	0.	0.	110.	0.	110.	25.	7.	22.	1.	6.4	1.9	54.	11.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	0.	410.	0.	0.	111.	0.	111.	25.	7.	22.	1.	6.5	1.9	54.	11.
1	TOT	0.	24170.	2565.	0.	6555.	1869.	8425.	1938.	558.	1718.	150.	456.4	137.5	4113.	846.
2	6	0.	413.	0.	0.	112.	0.	112.	37.	10.	56.	2.	1.6	0.4	95.	13.
2	10	617.	0.	248.	105.	0.	181.	286.	95.	27.	144.	6.	2.7	0.8	242.	34.
2	17	0.	410.	0.	0.	111.	0.	111.	36.	10.	55.	2.	1.6	0.4	94.	13.
2	TOT	1234.	18485.	497.	210.	5013.	362.	5587.	1852.	535.	2811.	117.	78.9	23.7	4742.	677.
3	6	361.	61.	0.	61.	16.	0.	78.	25.	7.	56.	2.	0.8	0.2	83.	9.
3	10	621.	0.	256.	106.	0.	187.	293.	97.	28.	211.	8.	2.1	0.6	311.	36.
3	17	0.	410.	0.	0.	111.	0.	111.	36.	10.	80.	3.	1.2	0.3	118.	14.
3	TOT	1705.	5518.	256.	291.	1496.	187.	1975.	654.	189.	1426.	55.	20.5	6.2	2102.	250.
4	6	0.	504.	0.	0.	136.	0.	136.	31.	9.	44.	12.	1.5	0.4	77.	22.
4	10	667.	0.	333.	114.	0.	243.	357.	82.	23.	114.	33.	2.6	0.7	199.	57.
4	17	0.	410.	0.	0.	111.	0.	111.	25.	7.	35.	10.	1.2	0.3	62.	18.
4	TOT	667.	24996.	333.	114.	6779.	243.	7137.	1642.	472.	2293.	665.	76.9	23.1	4012.	1161.
5	6	324.	236.	118.	55.	64.	86.	205.	12.	3.	64.	30.	2.2	0.6	78.	33.
5	10	765.	0.	496.	130.	0.	361.	492.	28.	7.	153.	71.	3.6	1.0	185.	80.
5	17	0.	410.	0.	0.	111.	0.	111.	6.	1.	34.	16.	1.2	0.3	42.	18.
5	TOT	1737.	6042.	850.	296.	1638.	619.	2555.	149.	39.	796.	373.	26.2	7.9	971.	420.
TOTAL		5345.	79213.	4504.	913.	21485.	3283.	25681.	6237.	1796.	9046.	1362.	659.1	198.5	15942.	3357.

SYSTEM 3 -10   LIGHT= 6   MEDIUM=11   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

- - - - - SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000) - - - - -

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	354.	54.	11.	6.	9.	5.8	1.7	361.	326.	68.	55.	0.252	63.	56.	50.	41.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	356.	54.	11.	6.	9.	5.8	1.7	360.	325.	72.	59.	3.309	75.	63.	43.	36.
1	TOT		26591.	4113.	846.	541.	668.	410.7	123.7	27024.	24370.	85.	70.	2.577	88.	73.	53.	44.
2	6	98.	360.	95.	13.	6.	9.	1.4	0.4	408.	335.	64.	54.	0.257	64.	54.	48.	40.
2	10	420.	900.	242.	34.	25.	24.	2.5	0.7	1025.	840.	170.	146.	0.536	170.	146.	106.	91.
2	17	5400.	356.	94.	13.	6.	9.	1.4	0.4	400.	328.	67.	57.	3.309	71.	60.	40.	34.
2	TOT		17882.	4742.	677.	332.	467.	71.0	21.3	20126.	16517.	71.	60.	2.801	74.	63.	44.	38.
3	6	98.	264.	83.	9.	4.	7.	0.7	0.2	312.	246.	49.	41.	0.278	49.	41.	34.	28.
3	10	420.	920.	311.	36.	26.	25.	1.9	0.5	1106.	860.	179.	149.	0.546	179.	149.	111.	93.
3	17	5400.	356.	118.	14.	6.	9.	1.0	0.3	422.	329.	69.	57.	3.309	72.	60.	41.	34.
3	TOT		6355.	2102.	250.	121.	169.	18.5	5.5	7537.	5883.	72.	59.	2.611	74.	62.	44.	37.
4	6	98.	439.	77.	22.	8.	11.	1.3	0.4	462.	414.	74.	67.	0.325	75.	67.	60.	54.
4	10	420.	1114.	199.	57.	32.	30.	2.3	0.7	1180.	1053.	200.	182.	0.646	201.	183.	126.	115.
4	17	5400.	356.	62.	18.	6.	9.	1.0	0.3	372.	333.	63.	57.	3.309	67.	61.	38.	35.
4	TOT		22860.	4012.	1161.	414.	597.	69.2	20.8	23881.	21364.	66.	60.	3.069	69.	63.	41.	37.
5	6	98.	651.	78.	33.	16.	17.	2.0	0.6	654.	616.	111.	103.	0.119	111.	103.	68.	63.
5	10	420.	1523.	185.	80.	47.	42.	3.2	0.9	1534.	1442.	267.	252.	0.858	268.	253.	172.	162.
5	17	5400.	356.	42.	18.	6.	9.	1.0	0.3	354.	333.	61.	57.	3.309	65.	61.	37.	35.
5	TOT		8118.	971.	420.	176.	216.	23.6	7.1	8102.	7623.	82.	77.	2.602	85.	80.	50.	47.
TOTAL			81808.	15942.	3357.	1587.	2120.	593.2	178.7	86673.	75760.	75.	65.	2.781	78.	67.	46.	40.

SYSTEM 3 -11 LIGHT= 8 MEDIUM=11 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	8	8	8	94.2	8.5	2658.	716.	716.	716.	4.	1.14	1.00	1.79	1.25
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
2	6	8	8	8	94.1	8.4	2703.	716.	716.	716.	4.	1.13	1.00	1.79	1.25
2	10	21	21	8	99.2	68.4	86388.	56.	56.	716.	43.	1.99	1.00	0.52	1.60
2	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
3	6	11	8	8	95.6	11.3	10374.	408.	716.	716.	5.	1.34	1.00	1.69	1.38
3	10	21	21	8	99.2	66.7	88241.	56.	56.	716.	45.	1.99	1.00	0.52	1.60
3	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
4	6	11	11	11	94.3	9.7	11710.	408.	408.	408.	10.	1.23	1.00	1.36	1.23
4	10	21	21	8	99.0	53.5	106356.	56.	56.	716.	56.	1.99	1.00	0.48	1.59
4	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58
5	6	21	11	8	98.8	43.2	138844.	56.	408.	716.	26.	1.97	1.00	0.70	1.62
5	10	21	21	8	98.7	37.8	144547.	56.	56.	716.	82.	1.95	1.00	0.44	1.55
5	17	0	0	8	97.0	16.4	11626.	0.	0.	716.	4.	1.60	1.00	1.79	1.58

SYSTEM 3 -11   LIGHT= 8   MEDIUM=11   HEAVY=21   ORIGIN= 1   CASE= 2   PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	408.	0.	0.	83.	0.	0.	83.	19.	5.	17.	1.	4.8	1.4	41.	8.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	423.	0.	0.	86.	0.	0.	86.	19.	5.	17.	1.	5.0	1.5	42.	8.
1	TOT	24818.	0.	2565.	5081.	0.	1869.	6951.	1599.	460.	1418.	124.	370.1	111.5	3387.	696.
2	6	415.	0.	0.	84.	0.	0.	84.	28.	8.	42.	1.	1.2	0.3	72.	10.
2	10	616.	0.	248.	126.	0.	181.	307.	101.	29.	154.	6.	2.9	0.9	259.	36.
2	17	423.	0.	0.	86.	0.	0.	86.	28.	8.	43.	1.	1.2	0.3	73.	10.
2	TOT	20251.	0.	497.	4146.	0.	362.	4509.	1494.	432.	2268.	95.	62.9	18.9	3826.	546.
3	6	361.	61.	0.	73.	16.	0.	90.	30.	8.	65.	2.	0.9	0.2	96.	11.
3	10	621.	0.	256.	127.	0.	187.	314.	104.	30.	227.	8.	2.2	0.6	333.	39.
3	17	423.	0.	0.	86.	0.	0.	86.	28.	8.	62.	2.	0.9	0.2	92.	11.
3	TOT	7213.	184.	256.	1476.	50.	187.	1714.	568.	164.	1238.	47.	17.6	5.3	182[illegible]	217.
4	6	0.	504.	0.	0.	136.	0.	136.	31.	9.	44.	12.	1.5	0.4	77.	22.
4	10	667.	0.	333.	136.	0.	243.	379.	87.	25.	122.	35.	2.7	0.8	212.	61.
4	17	423.	0.	0.	86.	0.	0.	86.	19.	5	27	8.	0.9	0.2	48.	14.
4	TOT	24400.	2019.	333.	4995.	547.	243.	5786.	1331.	383.	1859.	539.	62.0	18.7	3252.	941.
5	6	324.	236.	118.	66.	64.	86.	216.	12.	3.	67.	31.	2.3	0.7	82.	35.
5	10	764.	0.	496.	156.	0.	361.	518.	30.	8.	161.	75.	3.7	1.1	195.	84.
5	17	423.	0.	0.	86.	0.	0.	86.	5.	1.	27.	12.	0.9	0.2	33.	14.
5	TOT	7246.	703.	850.	1483.	192.	619.	2295.	134.	35.	715.	335.	23.2	7.0	872.	378.
TOTAL		83932.	2913.	4504.	17184.	790.	3283.	21257.	5128.	1476.	7499.	1142.	536.1	161.5	13163.	2780.

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SYSTEM 3 -11 LIGHT= 8 MEDIUM=11 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	278.	41.	8.	4.	7.	4.4	1.3	282.	255.	54.	45.	0.300	54.	45.	43.	36.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	288.	42.	8.	4.	7.	4.5	1.3	282.	254.	66.	56.	7.769	74.	64.	46.	40.
1	TOT		22470.	3387.	696.	460.	588.	333.1	100.3	22385.	20196.	78.	66.	5.968	84.	72.	55.	47.
2	6	98.	282.	72.	10.	5.	8.	1.1	0.3	317.	262.	51.	44.	0.306	52.	44.	41.	35.
2	10	420.	959.	259.	36.	26.	25.	2.6	0.8	1094.	895.	180.	154.	0.434	180.	154.	112.	96.
2	17	5400.	288.	73.	10.	4.	7.	1.1	0.3	313.	257.	62.	54.	7.769	70.	62.	44.	39.
2	TOT		14875.	3826.	546.	272.	409.	56.6	17.0	16318.	13406.	66.	57.	6.504	72.	64.	47.	41.
3	6	98.	299.	96.	11.	5.	8.	0.8	0.2	355.	279.	55.	45.	0.269	55.	46.	40.	33.
3	10	420.	980.	333.	39.	27.	26.	2.0	0.6	1180.	916.	189.	157.	0.442	189.	157.	118.	98.
3	17	5400.	288.	92.	11.	4.	7.	0.8	0.2	330.	257.	64.	54.	7.769	71.	62.	45.	39.
3	TOT		5631.	1824.	217.	106.	154.	15.8	4.7	6542.	5107.	70.	59.	6.015	76.	65.	48.	41.
4	6	98.	439.	77.	22.	8.	11.	1.3	0.4	462.	414.	74.	67.	0.325	75.	67.	60.	54.
4	10	420.	1178.	212.	61.	33.	32.	2.5	0.7	1249.	1115.	210.	191.	0.528	210.	192.	132.	120.
4	17	5400.	288.	48.	14.	4.	7.	0.8	0.2	291.	260.	59.	55.	7.769	67.	62.	42.	39.
4	TOT		19102.	3252.	941.	339.	522.	55.8	16.8	19416.	17375.	63.	58.	7.162	70.	65.	45.	42.
5	6	98.	682.	82.	35.	16.	18.	2.1	0.6	686.	645.	115.	108.	0.118	116.	108.	71.	66.
5	10	420.	1597.	195.	84.	48.	43.	3.4	1.0	1609.	1512.	278.	262.	0.707	279.	263.	179.	169.
5	17	5400.	288.	33.	14.	4.	7.	0.8	0.2	277.	260.	58.	55.	7.769	65.	62.	41.	39.
5	TOT		7398.	872.	378.	161.	202.	20.9	6.3	7272.	6841.	81.	76.	6.003	87.	82.	55.	52.
TOTAL			69478.	13163.	2780.	1339.	1877.	482.5	145.3	71936.	62928.	70.	62.	6.455	77.	68.	49.	44.

SYSTEM 3 -12 LIGHT= 5 MEDIUM=10 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 ASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	10	10	10	95.6	11.1	6189.	493.	493.	493.	6.	1.34	1.00	1.64	1.36
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.64	1.77
2	6	10	10	10	95.5	11.0	6292.	493.	493.	493.	6.	1.32	1.00	1.64	1.35
2	10	21	21	5	99.2	68.4	59990.	56.	56.	1228.	40.	1.99	1.00	0.56	1.61
2	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.64	1.77
3	6	21	5	5	96.1	12.6	57511.	56.	1228.	1228.	11.	1.42	1.00	0.87	1.27
3	10	21	21	5	99.2	66.7	61640.	56.	56.	1228.	42.	1.99	1.00	0.56	1.61
3	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.64	1.77
4	6	10	10	10	94.5	9.0	7676.	493.	493.	493.	8.	1.18	1.00	1.64	1.25
4	10	21	21	10	99.0	53.5	159223.	56.	56.	493.	60.	1.99	1.00	0.53	1.60
4	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.64	1.77
5	6	21	10	5	98.6	35.6	96092.	56.	493.	1228.	23.	1.94	1.00	0.77	1.61
5	10	21	21	5	98.7	37.8	111793.	56.	56.	1228.	78.	1.95	1.00	0.46	1.56
5	17	0	0	10	98.4	32.6	27066.	0.	0.	493.	6.	1.92	1.00	1.64	1.77

SYSTEM 3 -12 LIGHT= 5 MEDIUM=10 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)							
		AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T	A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1	6	0.	407.	0.	0.	100.	0.	100.	23.	6.	20.	1.	5.8	1.7	49.	10.
1	10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1	17	0.	413.	0.	0.	101.	0.	101.	23.	6.	20.	1.	5.9	1.7	50.	10.
1	TOT	0.	24303.	2565.	0.	5995.	1869.	7865.	1809.	521.	1604.	140.	423.6	127.6	3838.	789.
2	6	0.	414.	0.	0.	102.	0.	102.	33.	9.	51.	2.	1.4	0.4	86.	12.
2	10	617.	0.	248.	96.	0.	181.	277.	92.	26.	139.	5.	2.7	0.8	234.	33.
2	17	0.	413.	0.	0.	101.	0.	102.	33.	9.	51.	2.	1.4	0.4	86.	12.
2	TOT	1234.	18595.	497.	193.	4587.	362.	5143.	1705.	493.	2587.	108.	72.5	21.8	4365.	623.
3	6	361.	0.	61.	56.	0.	44.	101.	33.	9.	73.	2.	1.1	0.3	107.	12.
3	10	622.	0.	256.	97.	0.	187.	284.	94.	27.	205.	7.	2.0	0.6	301.	35.
3	17	0.	413.	0.	0.	101.	0.	101.	33.	9.	73.	2.	1.1	0.3	108.	12.
3	TOT	1706.	5370.	440.	266.	1324.	320.	1912.	633.	183.	1381.	53.	19.9	6.0	2035.	242.
4	6	0.	505.	0.	0.	124.	0.	124.	28.	8.	40.	11.	1.3	0.4	70.	20.
4	10	0.	667.	333.	0.	164.	243.	407.	93.	27.	131.	38.	2.9	0.8	227.	65.
4	17	0.	413.	0.	0.	101.	0.	101.	23.	6.	32.	9.	1.1	0.3	57.	16.
4	TOT	0.	25820.	333.	0.	6369.	243.	6613.	1521.	438.	2124.	616.	71.0	21.4	3717.	1076.
5	6	324.	236.	118.	50.	58.	86.	195.	11.	3.	60.	28.	2.1	0.6	74.	32.
5	10	765.	0.	496.	119.	0.	361.	481.	28.	7.	149.	70.	3.5	1.0	181.	78.
5	17	0.	413.	0.	0.	101.	0.	101.	5.	1.	31.	14.	1.1	0.3	38.	16.
5	TOT	1738.	6078.	850.	271.	1499.	619.	2391.	139.	37.	744.	349.	24.4	7.3	909.	393.
TOTAL		4679.	80168.	4687.	731.	19777.	3416.	23925.	5810.	1673.	8443.	1268.	611.6	184.2	14865.	3126.

SYSTEM 3 -12 LIGHT= 5 MEDIUM=10 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	326.	49.	10.	5.	8.	5.2	1.5	332.	300.	63.	51.	0.263	63.	52.	46.	38.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	330.	50.	10.	5.	8.	5.3	1.6	331.	299.	69.	57.	3.899	72.	61.	41.	34.
1	TOT		25014.	3838.	789.	508.	639.	381.3	114.8	25306.	22829.	81.	68.	3.027	84.	71.	51.	43.
2	6	98.	331.	86.	12.	5.	8.	1.3	0.4	374.	308.	59.	50.	0.268	60.	50.	44.	37.
2	10	420.	875.	234.	33.	25.	24.	2.4	0.7	996.	816.	166.	142.	0.757	167.	143.	103.	89.
2	17	5400.	330.	86.	12.	5.	8.	1.3	0.4	368.	302.	64.	55.	3.899	68.	59.	38.	33.
2	TOT		16633.	4365.	623.	307.	444.	65.2	19.6	18602.	15280.	68.	58.	3.302	71.	61.	42.	36.
3	6	98.	329.	107.	12.	7.	8.	0.9	0.3	391.	307.	62.	51.	0.259	62.	51.	49.	40.
3	10	420.	895.	301.	35.	25.	24.	1.8	0.5	1074.	836.	175.	145.	0.770	175.	146.	109.	91.
3	17	5400.	330.	108.	12.	5.	8.	1.0	0.3	388.	303.	66.	55.	3.899	70.	59.	39.	33.
3	TOT		6180.	2035.	242.	122.	165.	17.9	5.4	7299.	5698.	71.	59.	3.073	75.	63.	45.	33.
4	6	98.	404.	70.	20.	7.	11.	1.2	0.3	425.	381.	69.	62.	0.336	69.	62.	55.	50.
4	10	420.	1258.	227.	65.	35.	33.	2.6	0.8	1334.	1190.	222.	202.	0.521	223.	203.	139.	127.
4	17	5400.	330.	57.	16.	5.	8.	1.0	0.3	342.	306.	61.	55.	3.899	64.	59.	36.	33.
4	TOT		21388.	3717.	1076.	383.	569.	63.9	19.2	22203.	19870.	64.	58.	3.610	67.	62.	39.	36.
5	6	98.	621.	74.	32.	15.	17.	1.9	0.5	624.	587.	106.	99.	0.134	106.	99.	66.	61.
5	10	420.	1492.	181.	78.	46.	42.	3.1	0.9	1503.	1412.	263.	248.	1.192	264.	250.	169.	160.
5	17	5400.	330.	38.	16.	5.	8.	1.0	0.3	325.	306.	59.	55.	3.899	63.	59.	35.	33.
5	TOT		7655.	909.	393.	167.	208.	22.0	6.6	7609.	7160.	79.	74.	3.075	82.	77.	48.	45.
TOTAL			76872.	14865.	3126.	1490.	2027.	550.4	165.8	81020.	70839.	72.	62.	3.273	75.	66.	44.	39.

SYSTEM 3 -13 LIGHT= 5 MEDIUM=11 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

		CLASS			AVAILABILITY		S.L.	PLACEMENT RATE				NORMALIZED			
T	A	E	C	T	0/0	SORTIES	SORTIES	E	C	T	SORTIES	AVAIL	S.L.	P.R.	EFFECT.
1	6	11	11	11	96.0	12.3	9442.	408.	408.	408.	8.	1.41	1.00	1.36	1.36
1	10	21	21	21	99.2	69.8	336273.	56.	56.	56.	126.	1.99	1.00	0.28	1.55
1	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.36	1.74
2	6	11	11	11	95.9	12.1	9598.	408.	408.	408.	8.	1.39	1.00	1.36	1.35
2	10	21	21	5	99.2	68.4	59990.	56.	56.	1228.	40.	1.99	1.00	0.56	1.61
2	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.36	1.74
3	6	11	5	5	95.1	10.1	3507.	408.	1228.	1228.	3.	1.26	1.00	2.49	1.48
3	10	21	21	5	99.2	66.7	61640.	56.	56.	1228.	42.	1.99	1.00	0.56	1.61
3	17	0	0	11	[illegible]	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.36	1.74
4	6	11	11	11	94.9	9.7	11710.	408.	408.	408.	10.	1.23	1.00	1.36	1.23
4	10	21	21	11	99.0	53.5	207920.	56.	56.	408.	62.	1.99	1.00	0.51	1.59
4	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.36	1.74
5	6	21	11	5	98.6	43.2	101837.	56.	408.	1228.	24.	1.97	1.00	0.74	1.62
5	10	21	21	5	98.7	37.8	111793.	56.	56.	1228.	78.	1.95	1.00	0.46	1.56
5	17	0	0	11	98.7	38.7	41288.	0.	0.	408.	8.	1.95	1.00	1.36	1.74

SYSTEM 3 -13 LIGHT= 5 MEDIUM=11 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

	AREA AND WEIGHT OF MEMBRANE AND ACCESSORIES							TRANSPORTATION COSTS ($1000)							
	AREA (1000 SQ FT)			WEIGHT (TONS)				ORIGIN-PORT		CONUS-COMMZ		COMMZ-FIELD		TOTAL	
T A	LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	TOTAL	AIR	TRUCK	AIR	SHIP	AIR	TRUCK	AIR	SURFACE
1 6	0.	407.	0.	0.	110.	0.	110.	25.	7.	22.	1.	6.4	1.9	54.	11.
1 10	0.	0.	855.	0.	0.	623.	623.	143.	41.	127.	11.	24.3	7.3	294.	59.
1 17	0.	410.	0.	0.	111.	0.	111.	25.	7.	22.	1.	6.5	1.9	54.	11.
1 TOT	0.	24170.	2565.	0.	6555.	1869.	8425.	1938.	558.	1718.	150.	456.4	137.5	4113.	846.
2 6	0.	413.	0.	0.	112.	0.	112.	37.	10.	56.	2.	1.5	0.4	95.	13.
2 10	617.	0.	248.	96.	0.	181.	277.	92.	26.	139.	5.	2.7	0.8	234.	33.
2 17	0.	410.	0.	0.	111.	0.	111.	36.	10.	55.	2.	1.6	0.4	54.	13.
2 TOT	1234.	18485.	497.	193.	5013.	362.	5569.	1846.	534.	2802.	117.	78.7	23.7	4727.	675.
3 6	361.	61.	0.	56.	16.	0.	73.	24.	7.	52.	2.	0.8	0.2	77.	9.
3 10	622.	0.	256.	97.	0.	187.	284.	94.	27.	205.	7.	2.0	0.6	301.	35.
3 17	0.	410.	0.	0.	111.	0.	111.	36.	10.	80.	3.	1.2	0.3	118.	14.
3 TOT	1706.	5518.	256.	266.	1496.	187.	1950.	646.	187.	1409.	54.	20.3	6.1	2076.	247.
4 6	0.	504.	0.	0.	136.	0.	136.	31.	9.	44.	12.	1.5	0.4	77.	22.
4 10	0.	667.	333.	0.	180.	243.	424.	97.	28.	136.	39.	3.1	0.9	237.	68.
4 17	0.	410.	0.	0.	111.	0.	111.	25.	7.	35.	10.	1.2	0.3	62.	18.
4 TOT	0.	25663.	333.	0.	6960.	243.	7204.	1657.	477.	2314.	671.	77.4	23.3	4049.	1172.
5 6	324.	236.	118.	50.	64.	86.	200.	11.	3.	62.	29.	2.2	0.6	76.	33.
5 10	765.	0.	496.	119.	0.	361.	481.	28.	7.	149.	70.	3.5	1.0	181.	78.
5 17	0.	410.	0.	0.	111.	0.	111.	6.	1.	34.	16.	1.2	0.3	42.	18.
5 TOT	1738.	6042.	850.	271.	1638.	619.	2530.	148.	39.	788.	369.	25.9	7.8	962.	416.
TOTAL	4679.	79880.	4504.	731.	21666.	3283.	25681.	6237.	1796.	9033.	1364.	659.0	198.5	15929.	3358.

SYSTEM 3 -13 LIGHT= 5 MEDIUM=11 HEAVY=21 ORIGIN= 1 CASE= 2 PARAMETERS - 1 PASS

SUMMARY OF MEMBRANE-RELATED COSTS PER FIELD ($ 1000)

T	A	SORT-IES	INITIAL	ORIGIN-FIELD AIR	ORIGIN-FIELD SURF.	EM-PLACE	RE-COVER	FIELD-COMMZ AIR	FIELD-COMMZ SURF.	RECOVERED VALUE AIR	RECOVERED VALUE SURF.	FIXED AIR	FIXED SURF.	MAINT.	TOTAL AIR	TOTAL SURF.	COST-EFF. AIR	COST-EFF. SURF.
1	6	98.	354.	54.	11.	6.	9.	5.8	1.7	361.	326.	68.	55.	0.252	68.	56.	50.	41.
1	10	420.	1854.	294.	59.	57.	40.	21.8	6.5	1912.	1716.	357.	303.	0.414	357.	303.	229.	195.
1	17	5400.	356.	54.	11.	6.	9.	5.8	1.7	360.	32[illegible].	72.	59.	3.309	75.	63.	43.	36.
1	TOT		26591.	4113.	846.	541.	663.	410.7	123.7	27024.	24370.	85.	70.	2.577	88.	73.	53.	44.
2	6	98.	360.	95.	13.	6.	9.	1.4	0.4	408.	335.	64.	54.	0.257	64.	54.	48.	40.
2	10	420.	875.	234.	33.	25.	24.	2.4	0.7	996.	816.	166.	142.	0.757	167.	143.	103.	89.
2	17	5400.	356.	94.	13.	6.	9.	1.4	0.4	400.	328.	67.	57.	3.309	71.	60.	40.	34.
2	TOT		17832.	4727.	675.	331.	467.	70.8	21.3	20067.	16470.	71.	60.	2.811	74.	63.	44.	37.
3	6	98.	250.	77.	9.	4.	7.	0.7	0.2	293.	232.	47.	39.	0.285	47.	39.	31.	26.
3	10	420.	895.	301.	35.	25.	24.	1.8	0.5	1074.	836.	175.	145.	0.770	175.	146.	109.	91.
3	17	5400.	356.	118.	14.	6.	9.	1.0	0.3	422.	329.	69.	57.	3.309	72.	60.	41.	34.
3	TOT		6285.	2076.	247.	120.	168.	18.3	5.5	7451.	5818.	71.	59.	2.626	74.	62.	43.	36.
4	6	98.	439.	77.	22.	8.	11.	1.3	0.4	462.	414.	74.	67.	0.325	75.	67.	60.	54.
4	10	420.	1304.	237.	68.	35.	34.	2.7	0.8	1384.	1234.	230.	209.	0.520	230.	210.	144.	131.
4	17	5400.	356.	62.	18.	6.	9.	1.0	0.3	372.	333.	63.	57.	3.309	67.	61.	38.	35.
4	TOT		23050.	4049.	1172.	417.	600.	69.7	21.0	24086.	21545.	67.	60.	3.067	70.	63.	41.	37.
5	6	98.	638.	76.	33.	16.	17.	1.9	0.5	641.	603.	109.	102.	0.120	109.	102.	67.	62.
5	10	420.	1492.	181.	78.	46.	42.	3.1	0.9	1503.	1412.	263.	248.	1.192	264.	250.	169.	160.
5	17	5400.	356.	42.	18.	6.	9.	1.0	0.3	354.	333.	61.	57.	3.309	65.	61.	37.	35.
5	TOT		80[illegible]7.	962.	416.	175.	215.	23.3	7.0	8030.	7555.	81.	76.	2.621	84.	79.	50.	47.
TOTAL			81807.	15929.	3358.	1587.	2119.	593.1	178.6	86660.	75760.	75.	65.	2.785	78.	67.	46.	40.

APPENDIX D

DATA SHEET FOR COATED FABRIC MEMBRANES

Membrane	Coating	Fabric	Ply	Weight (lb/sq ft)	Tensile Strength Warp (lb/sq ft)	Tensile Strength Fill (lb/sq ft)	Tensile Strength Avg (lb/sq ft)	Original Cost ($/sq ft)	Date of Cost
T1	Vinyl	18 oz cotton duck	1	0.244	337	250	294	0.16	1958
T2	Vinyl	10 oz cotton duck	1	0.170	225	144	185	0.13	1958
T11	Neoprene	Tire cord		0.560				0.56	1953
T12	Neoprene	8 oz nylon	1	0.292	746	543	645	0.64	1959
T13	Vinyl	8 oz nylon	1	0.167				0.64	1960
T14	Neoprene	8 oz nylon	1	0.333				0.70	1960
T15	Vinyl	3.2 oz nylon	1	0.130	314	318	316	0.20	1962
T16	Neoprene	5.1 oz nylon	1	0.130	497	462	480	0.25	1963
T17	Neoprene	5.1 oz nylon	2	0.333	1021	890	956	0.55	1966
WX-18	Neoprene	5.1 oz nylon	4	0.456	2157	1959	2058	0.88	1968
PBS	Bituminous	Burlap	1	0.390				0.09	1943
PSN1 (British)	Neoprene	Nylon	1	0.125					1967
PVC (British)	Neoprene	Nylon	1	0.146					1967